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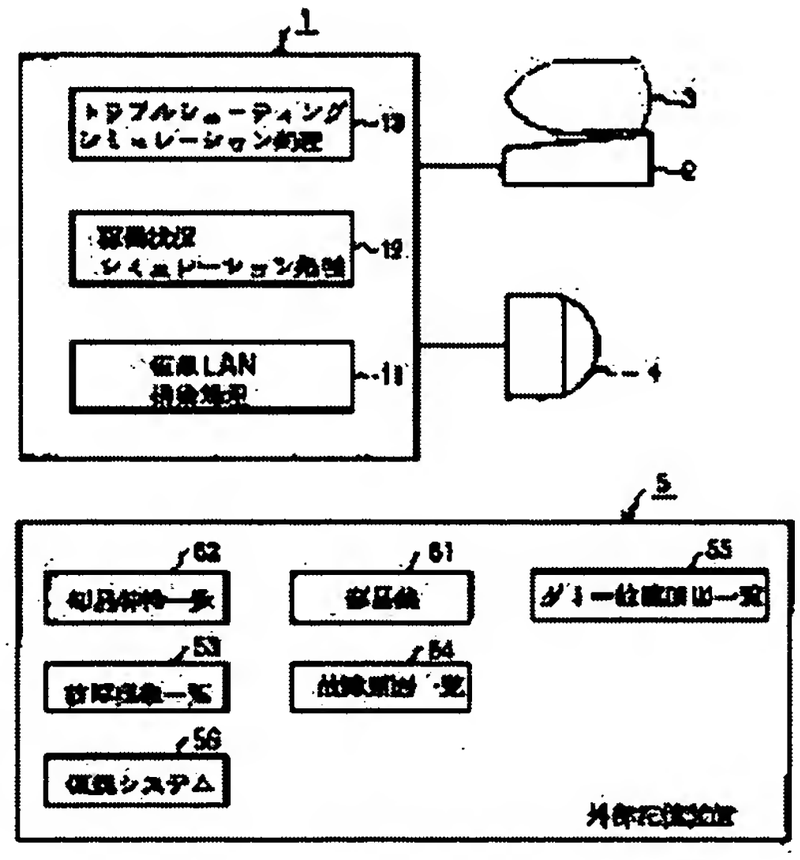
(54) NETWORK SIMULATOR AND STORAGE MEDIUM FOR SIMULATION

(57)Abstract:
PROBLEM TO BE SOLVED: To allow the simulator to aid the management job by building up a network model in the interior of a computer and simulating progress of deterioration by a specific processing procedure so as to depict the reliability in terms of figures such as MTBF.
SOLUTION: The user starts a virtual LAN buildup processing program 11 of a computer 1 and connects components in a component list table 51 onto a screen of a display device 3. Then data of connection relationship denoting the configuration of the virtual network are registered in a virtual system storage table 56 with a sequential number and able to be reproduced on the display device 3 at any time. When an operation state simulation processing program 12 is started, the program executes repetitively the simulation of fault occurrence as to any of virtual LAN components based on data such as a failure rate and a deterioration factor in a component characteristic table 52 and provides an output of an estimated MTBF(mean time between failures) after the lapse of the operating period set by the user by means of the Monte Carlo method.



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審査請求　未請求　請求項の数４　ＯＬ　（全 13 頁）

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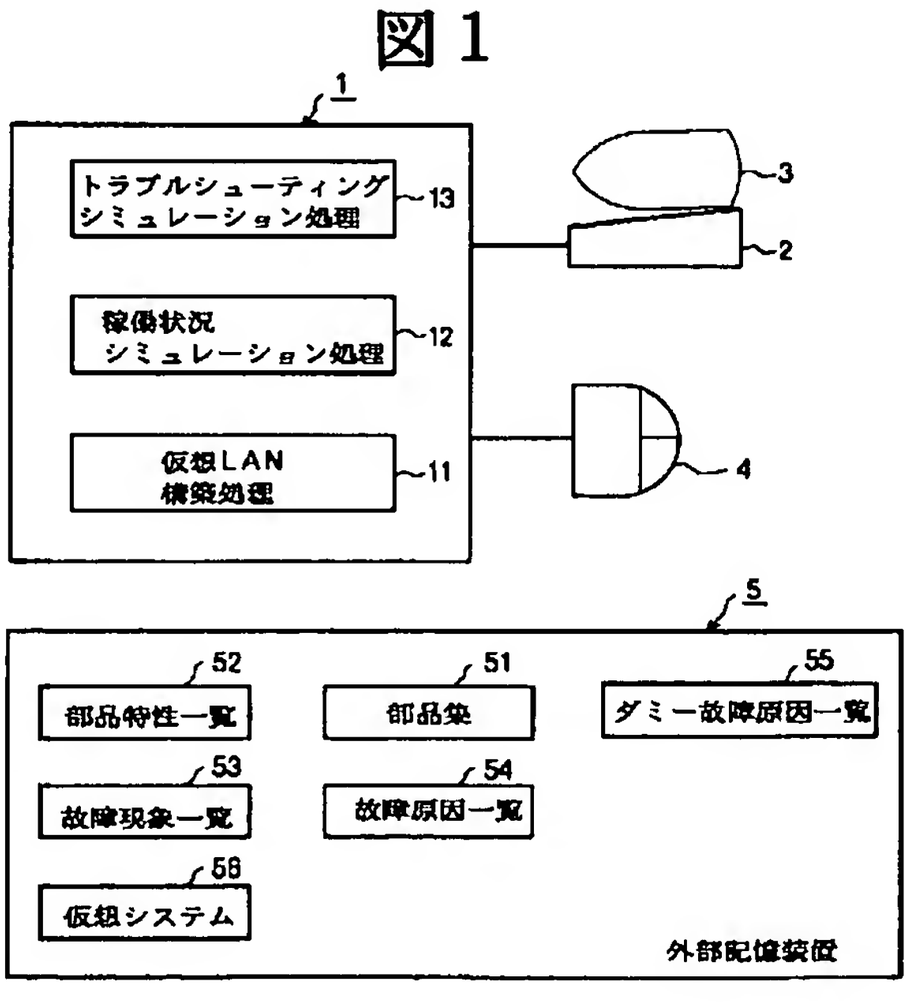
(54)【発明の名称】　ネットワークシミュレータおよびシミュレーション用記憶媒体

(57)【要約】
【課題】　構成部品の経年変化を含めたネットワークシステムの信頼性をＭＴＢＦ等の数値で速やかに提示し、管理業務を支援すること。
【解決手段】　コンピュータ内部に仮想のネットワークを構築し、その仮想ネットワーク構成部品のいずれか１つをランダムに選出し、その選出部品の故障率と乱数によって生成した仮想故障率とを比較し、仮想故障率が小さい場合は選出部品に障害が発生したものと見做し、障害回数カウント値を更新する処理を所定回数繰返し、所定回数に達した時点での障害回数カウント値に基づいてＭＴＢＦを算出すると共に、仮想ネットワーク構成部品の全ての故障率を各構成部品の劣化率によって補正する処理を、ユーザの設定回数分繰返し、ユーザの設定回数分繰り返した時点で各繰返し単位別のＭＴＢＦを出力する。

図１



【特許請求の範囲】
【請求項１】　ネットワークを構築する上で必要となる複数の構成部品のデータを記憶した構成部品テーブルと、
各構成部品の故障率，経年変化に伴う劣化率を含む特性データを記憶した部品特性一覧テーブルと、
前記構成部品テーブルの構成部品のデータのうちユーザが指定した構成部品のデータをユーザが指定した接続関係で接続し、コンピュータ内部に仮想のネットワークを構築する仮想ネットワーク構築手段と、
構築された仮想ネットワークを構成する構成部品の特性データを前記部品特性一覧テーブルから取得し、仮想ネットワーク構成部品特性データリストとして保持する保持手段と、
仮想ネットワーク構成部品のいずれか１つをランダムに選出し、その選出部品の故障率と乱数によって生成した仮想故障率とを比較し、仮想故障率が小さい場合は選出部品に障害が発生したものと見做し、障害回数カウント値を更新する処理を所定回数繰返す第１の処理と、所定回数に達した時点での前記障害回数カウント値に基づいてＭＴＢＦを算出すると共に、仮想ネットワーク構成部品の全ての故障率を各構成部品の劣化率によって補正し、前記保持手段中の構成部品の故障率を補正後の故障率に置換した後、前記第１の処理に引き継ぐ処理をユーザの設定回数分繰返し、ユーザの設定回数分繰り返した時点で各繰返し単位別のＭＴＢＦを出力する第２の処理とを行うＭＴＢＦ算出手段と、を備えたことを特徴とするネットワークシミュレータ。
【請求項２】　ネットワークを構築する上で必要となる複数の構成部品のデータを記憶した構成部品テーブルと、
各構成部品の故障率，経年変化に伴う劣化率を含む特性データを記憶した部品特性一覧テーブルと、
各構成部品のそれぞれについて故障現象の内容を現象別に記憶した故障現象一覧テーブルと、
各構成部品のそれぞれについて前記故障現象のそれぞれに対応する故障原因の内容を記憶した故障原因一覧テーブルと、
各構成部品のそれぞれについて前記故障現象のそれぞれに対応する偽の故障原因の内容を記憶した偽故障原因一覧テーブルと、
前記構成部品テーブルの構成部品のデータのうちユーザが指定した構成部品のデータをユーザが指定した接続関係で接続し、コンピュータ内部に仮想のネットワークを構築する仮想ネットワーク構築手段と、
構築された仮想ネットワークを構成する構成部品の特性データを前記部品特性一覧テーブルから取得し、仮想ネットワーク構成部品特性データリストとして保持する保持手段と、
仮想ネットワーク構成部品のいずれか１つをランダムに選出し、その選出部品の故障率と乱数によって生成した仮想故障率とを比較し、仮想故障率が小さい場合は選出部品に障害が発生したものと見做し、その選出部品の故障現象および故障原因ならびに偽故障原因の内容を前記故障現象一覧テーブル，故障原因一覧テーブルおよび偽故障原因一覧テーブルからランダムに取得して表示画面に表示させる出題内容選出手段と、
表示された故障現象に対し、ユーザが回答した故障原因が正解か否かを判定し、判定結果のメッセージを出力する判定手段と、を備えたことを特徴とするネットワークシミュレータ。
【請求項３】　ネットワークを構築する上で必要となる複数の構成部品のデータを記憶した構成部品テーブルと、
各構成部品の故障率，経年変化に伴う劣化率を含む特性データを記憶した部品特性一覧テーブルと、
前記構成部品テーブルの構成部品のデータのうちユーザが指定した構成部品のデータをユーザが指定した接続関係で接続し、コンピュータ内部に仮想のネットワークを構築する仮想ネットワーク構築処理と、
構築された仮想ネットワークを構成する構成部品の特性データを前記部品特性一覧テーブルから取得し、仮想ネットワーク構成部品特性データリストとして保持する保持手段と、
仮想ネットワーク構成部品のいずれか１つをランダムに選出し、その選出部品の故障率と乱数によって生成した仮想故障率とを比較し、仮想故障率が小さい場合は選出部品に障害が発生したものと見做し、障害回数カウント値を更新する処理を所定回数繰返す第１の処理と、所定回数に達した時点での前記障害回数カウント値に基づいてＭＴＢＦを算出すると共に、仮想ネットワーク構成部品の全ての故障率を各構成部品の劣化率によって補正し、前記保持手段中の構成部品の故障率を補正後の故障率に置換した後、前記第１の処理に引き継ぐ処理をユーザの設定回数分繰返し、ユーザの設定回数分繰り返した時点で各繰返し単位別のＭＴＢＦを出力する第２の処理とを行うＭＴＢＦ算出処理と、を含むコンピュータが実行可能なプログラムおよびテーブルを記憶したことを特徴とするネットワークシミュレーション用記憶媒体。
【請求項４】　ネットワークを構築する上で必要となる複数の構成部品のデータを記憶した構成部品テーブルと、
各構成部品の故障率，経年変化に伴う劣化率を含む特性データを記憶した部品特性一覧テーブルと、
各構成部品のそれぞれについて故障現象の内容を現象別に記憶した故障現象一覧テーブルと、
各構成部品のそれぞれについて前記故障現象のそれぞれに対応する故障原因の内容を記憶した故障原因一覧テーブルと、
各構成部品のそれぞれについて前記故障現象のそれぞれ

に対応する偽の故障原因の内容を記憶した偽故障原因一覧テーブルと、
前記構成部品テーブルの構成部品のデータのうちユーザが指定した構成部品のデータをユーザが指定した接続関係で接続し、コンピュータ内部に仮想のネットワークを構築する仮想ネットワーク構築処理と、
構築された仮想ネットワークを構成する構成部品の特性データを前記部品特性一覧テーブルから取得し、仮想ネットワーク構成部品特性データリストとして保持する保持手段と、
仮想ネットワーク構成部品のいずれか１つをランダムに選出し、その選出部品の故障率と乱数によって生成した仮想故障率とを比較し、仮想故障率が小さい場合は選出部品に障害が発生したものと見做し、その選出部品の故障現象および故障原因ならびに偽故障原因の内容を前記故障現象一覧テーブル，故障原因一覧テーブルおよび偽故障原因一覧テーブルからランダムに取得して表示画面に表示させる出題内容選出処理と、
表示された故障現象に対し、ユーザが回答した故障原因が正解か否かを判定し、判定結果のメッセージを出力する判定処理と、を含むコンピュータが実行可能なプログラムおよびテーブルを記憶したことを特徴とするネットワークシミュレーション用記憶媒体。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、ＬＡＮ等のネットワーク管理者の管理業務の支援または教育を行うネットワークシミュレータおよびネットワークシミュレーション用記憶媒体に関するものである。
【０００２】
【従来の技術】近年、コンピュータと通信回線を接続し、構内や遠距離地点間で文書や画像、音声等の情報を交換可能にしたＬＡＮ，ＷＡＮ等の各種の規模のネットワークシステムが開発されている。
【０００３】このようなネットワークシステムでは、サーバマシンや通信回線等の中核となる部分が故障すると、ネットワーク全体または一部分が運用不可能になる等の重大な事態になる。
【０００４】そこで、従来においては、サーバやディスク，通信回線等を２重化することにより、システムに冗長性を持たせ、信頼性を向上させる対策が施されている。
【０００５】また、ネットワークの構成要素であるサーバマシンやクライアントマシンを導入するに際して、可能な限り故障率の低いものを選定することによってシステム全体の信頼性が高くなるように考慮している。
【０００６】しかしながら、この種のネットワークシステムは、必要に応じてクライアントマシン等のネットワーク機器が増減されるという柔軟性を１つの特徴として備えている。このため、ネットワークシステムの運用開始時に、サーバマシン，クライアントマシン，通信回線等の個々の構成要素の故障率を積算してシステム全体の故障率を見積もったとしても、その見積りはネットワーク機器の増減によって大きく変化してしまう。
【０００７】そこで、従来においては、ネットワーク機器の増減の都度、人手によってシステム全体の故障率を再計算し、その計算結果によってシステム全体の信頼性を把握することが試みられている。
【０００８】
【発明が解決しようとする課題】しかしながら、人手によってシステム全体の故障率を再計算する方法では、時間と労力がかかり、緊急を要する場合に速やかに対応できないという問題がある。
【０００９】また、信頼性を定量的に示す数値としては、ＭＴＢＦ（平均故障間隔）や稼働率等の数値があるが、個々の構成部品の故障率の他に経年変化をも考慮し、これらのＭＴＢＦ等の数値を計算し、速やかに提示することができないという問題がある。
【００１０】さらに、２重化を行うことで信頼性を向上させたとしても、２重化しない場合との信頼性の絶対的な比較ができないため、要求される信頼性以上の信頼性向上を施しコストの無駄が生じている可能性、またその逆に２重化だけでは要求信頼性を満たしていない状態を把握することができないという問題がある。
【００１１】一方、ネットワークシステムの信頼性の概念が不明確ななかで、実際にネットワークシステムを構築し、これを管理する管理者の管理技術の習得に関しては、従来は書籍での学習と実際の管理経験が中心であり、管理者の育成には多大な時間と経費がかかっている。このため、養成コストの削減と管理者が交代する場合等に備えて後任の管理者を速やかに効率良く養成する教育システムの実現が望まれている。
【００１２】本発明はこのような問題を解決するためになされたものであり、その第１の目的は、構成部品の経年変化を含めたネットワークシステムの信頼性をＭＴＢＦ等の数値で速やかに提示し、管理業務を支援することができるネットワークシミュレータおよびネットワークシミュレーション用記憶媒体を提供することにある。
【００１３】本発明の第２の目的は、トラブルシューティング実習を可能とし、ネットワーク管理者を効率良く養成することができるネットワークシミュレータおよびネットワークシミュレーション用記憶媒体を提供することにある。
【００１４】
【課題を解決するための手段】本発明は、上記第１の目的を達成するために、ネットワークを構築する上で必要となる複数の構成部品のデータを記憶した構成部品テーブルと、各構成部品の故障率，経年変化に伴う劣化率を含む特性データを記憶した部品特性一覧テーブルと、前記構成部品テーブルの構成部品のデータのうちユーザが

指定した構成部品のデータをユーザが指定した接続関係で接続し、コンピュータ内部に仮想のネットワークを構築する仮想ネットワーク構築手段と、構築された仮想ネットワークを構成する構成部品の特性データを前記部品特性一覧テーブルから取得し、仮想ネットワーク構成部品特性データリストとして保持する保持手段と、仮想ネットワーク構成部品のいずれか１つをランダムに選出し、その選出部品の故障率と乱数によって生成した仮想故障率とを比較し、仮想故障率が小さい場合は選出部品に障害が発生したものと見做し、障害回数カウント値を更新する処理を所定回数繰返す第１の処理と、所定回数に達した時点での前記障害回数カウント値に基づいてＭＴＢＦを算出すると共に、仮想ネットワーク構成部品の全ての故障率を各構成部品の劣化率によって補正し、前記保持手段中の構成部品の故障率を補正後の故障率に置換した後、前記第１の処理に引き継ぐ処理をユーザの設定回数分繰返し、ユーザの設定回数分繰り返した時点で各繰返し単位別のＭＴＢＦを出力する第２の処理とを行うＭＴＢＦ算出手段とを設けたことを特徴とする。

【００１５】ここで、第１の処理における所定回数として、例えば、１年を１時間単位で区分した値「３６５×２４＝８７６０」に設定すれば、第１の処理を１回繰り返すことによって１年経過後のＭＴＢＦが得られる。

【００１６】また、上記第２の目的を達成するために、ネットワークを構築する上で必要となる複数の構成部品のデータを記憶した構成部品テーブルと、各構成部品の故障率，経年変化に伴う劣化率を含む特性データを記憶した部品特性一覧テーブルと、各構成部品のそれぞれについて故障現象の内容を現象別に記憶した故障現象一覧テーブルと、各構成部品のそれぞれについて前記故障現象のそれぞれに対応する故障原因の内容を記憶した故障原因一覧テーブルと、各構成部品のそれぞれについて前記故障現象のそれぞれに対応する偽の故障原因の内容を記憶した偽故障原因一覧テーブルと、前記構成部品テーブルの構成部品のデータのうちユーザが指定した構成部品のデータをユーザが指定した接続関係で接続し、コンピュータ内部に仮想のネットワークを構築する仮想ネットワーク構築手段と、構築された仮想ネットワークを構成する構成部品の特性データを前記部品特性一覧テーブルから取得し、仮想ネットワーク構成部品特性データリストとして保持する保持手段と、仮想ネットワーク構成部品のいずれか１つをランダムに選出し、その選出部品の故障率と乱数によって生成した仮想故障率とを比較し、仮想故障率が小さい場合は選出部品に障害が発生したものと見做し、その選出部品の故障現象および故障原因ならびに偽故障原因の内容を前記故障現象一覧テーブル，故障原因一覧テーブルおよび偽故障原因一覧テーブルからランダムに取得して表示画面に表示させる出題内容選出手段と、表示された故障現象に対し、ユーザが回答した故障原因が正解か否かを判定し、判定結果のメッセージを出力する判定手段とを備えることを特徴とする。

【００１７】

【発明の実施の形態】以下、本発明の実施の形態を図面を用いて具体的に説明する。

【００１８】図１は、本発明を適用したＬＡＮシミュレータの実施形態を示すシステム構成図であり、コンピュータ１と、その入出力機器であるキーボード２、ディスプレイ３、マウス（ポインティングデバイス）４、ハードウェアディスク等の外部記憶装置５とから構成されている。

【００１９】コンピュータ１の内部には、ネットワーク構成部品の経年変化を含めたネットワークシステムの信頼性をＭＴＢＦ等の数値で速やかに提示し、管理業務を支援することと、トラブルシューティング実習を可能とし、ネットワーク管理者を効率良く養成するために、仮想ＬＡＮ構築処理１１、稼働状況シミュレータ処理１２、トラブルシューティング処理１３がアプリケーションプログラムとして組み込まれている。

【００２０】これらの各処理１１，１２，１３は、コンピュータ１が実行可能なデータ形式でＣＤ－ＲＯＭ等の記憶媒体に記憶され、コンピュータ１のユーザに提供される。

【００２１】一方、外部記憶装置５には、部品集テーブル（構成部品テーブル）５１、部品特性一覧テーブル５２、故障現象一覧テーブル５３、故障原因一覧テーブル５４、ダミー故障原因一覧テーブル（偽故障原因一覧テーブル）５５、仮想システム保持テーブル５６が設けられている。

【００２２】部品集テーブル５１は、ユーザが所望の仮想ネットワークを構築する上で必要となる複数の構成部品のデータを記憶したものであり、図２に示すように、イーサネット、トークンリング、クライアントマシン等の構成部品をアイコン形式で表示するためのデータを記憶している。

【００２３】部品特性一覧テーブル５２は、各構成部品の故障率，経年変化に伴う劣化率を含む特性データを記憶したものであり、図３に示すように、イーサネット等の構成部品に付けられた部品番号３０１、構成部品の名称３０２、故障率３０３、劣化率３０４、現象総数３０５の欄を備え、各欄にイーサネット等の構成部品の名称、故障率劣化率、現象総数が部品番号別に設定されている。

【００２４】ここで、故障率とは、部品番号３０１で特定される部品の１時間当たりの故障発生確率であり、１時間当たりの故障回数で定義する。すなわち、部品ｎがＴ時間の間にＮ回故障したとすると、この部品ｎの故障率Ｐｎは数式（１）に示すように定義される。

【００２５】

【数１】

$$P_n \equiv \frac{N}{T}$$

【００２６】劣化率とは、部品番号３０１で特定される部品の経年劣化を表わす指標であり、１年経過毎の故障発生確率の増加分であり、百分率で表現する。すなわち、部品ｎの工場出荷時の故障率をＰｎ（φ）、１年間稼働後の故障率をＰｎ（１）とすると、劣化率αｎは数式（２）によって定義される。

【００２７】

【数２】

$$\alpha_n \equiv \left(\frac{P_{n(1)}}{P_{n(\phi)}} - 1 \right) \times 100$$

【００２８】例えば、ある部品の故障率が「０．５」であり、この部品の劣化率が「２０」である場合、この部品の翌年の故障率を計算すると「０．５×（１００＋２０）／１００＝０．６」となる。

【００２９】また、現象総数とは、部品番号３０１で特定された部品その構成部品が故障となった際に現れる現象の総数であり、経験値を基に設定される。例えば、現象総数が「１」ということは、故障時の現象が１種類しか無いことを表している。

【００３０】故障現象一覧テーブル５３は、各構成部品のそれぞれについて故障現象の内容を現象別に記憶したものであり、図４に示すように、部品番号４０１、シーケンス番号４０２、現象内容４０３の欄を備え、各構成部品が故障した際に現れる現象の内容がシーケンス番号別に記憶されている。

【００３１】シーケンス番号４０２は、同一部品番号に属する複数の現象を一意に区別するために付けられた識別番号であり、部品番号４０１とシーケンス番号４０２の２つの項目で主キーとなっている。各部品番号内で「１」から順に付番される。現象内容４０３は、ＬＡＮシステムに発生した現象の内容、例えば「ネットワーク全体がダウンした」等である。

【００３２】ここで、現象内容の個数は、部品特性一覧テーブル５２の現象総数３０５の値に等しい。すなわち、この故障現象一覧テーブル５３には、各構成部品が故障した際に現れる現象の内容が全てシーケンス番号を付して設定されている。

【００３３】故障原因一覧テーブル５４は、各構成部品のそれぞれについて前記故障現象のそれぞれに対応する故障原因の内容を記憶したものであり、図５に示すように、部品番号５０１、シーケンス番号５０２、原因要約５０３、詳細説明５０４の欄を備え、各構成部品が故障した際にその原因と考えられる内容の要約と詳細説明が現象別に（シーケンス番号別に）設定されている。

【００３４】ここで、原因要約５０３は、「回線障害」等の発生した故障を簡単に説明するキーワードである。詳細説明５０４は、発生した障害の原因の詳細な説明であり、例えば「回線の終端抵抗が外れたため、回線の終端で信号の反射が生じて、通信信号と打ち消し合い通信不能となった」等の説明文が登録されている。

【００３５】ダミー故障原因一覧テーブル５５は、各構成部品のそれぞれについて前記故障現象のそれぞれに対応する偽の故障原因の内容を記憶したものであり、図６に示すように、部品番号６０１、シーケンス番号６０２、ダミー部品番号（１）６０３、ダミー部品番号（２）６０４、ダミーシーケンス番号（１）６０５、ダミーシーケンス番号（２）６０６の欄を備え、各構成部品のそれぞれについて前記故障現象のそれぞれに対応する偽の故障原因と偽の故障部品が設定されている。

【００３６】ここで、ダミー部品番号（１）６０３、ダミー部品番号（２）６０４は、例えば部品番号＝１の構成部品が故障し、シーケンス番号＝１の現象を呈していた時に、偽の故障部品の故障現象を同時に表示し、部品番号＝１の構成部品が故障した時の正しい故障原因を回答させるために設定されたものである。従って、ダミー部品を選定する場合は、真の故障部品と故障現象が類似しているものの方が難易度が高くなる。

【００３７】仮想システム保持テーブル５６は、仮想ＬＡＮ構築処理を使用してユーザが構築した仮想ＬＡＮの構成部品のデータを記憶したもので、図７に示すように、整理番号７０１、部品番号７０２、名称７０３、故障率７０４、劣化率７０５、現象総数７０６の欄を備え、ユーザが構築した仮想ＬＡＮを構成する個々の部品について整理番号が付けられ、その整理番号別に、部品番号、名称、故障率、劣化率、現象総数が設定される。

【００３８】この場合、各構成部品の接続関係も登録される。

【００３９】ここで、整理番号７０１は、仮想ＬＡＮシステムの構成部品の各々に対して、一意に割り振った番号である。部品番号７０２との相違点は、部品番号７０２がその部品の種類別に割り振られるのに対して、整理番号７０１は部品個々に対して割り振られる。従って、仮想ＬＡＮシステム内では、整理番号７０１を指定することで１個の部品を一意に指定できる。また、整理番号７０１は仮想システム保持テーブル５６の主キーの役割をもつ。

【００４０】仮想ＬＡＮ構築処理１１は、部品集テーブル５１の中に登録された構成部品のデータのうちユーザが指定した構成部品のデータでコンピュータ１内部に仮想のネットワークを構築する処理を行うものであり、仮想ＬＡＮを構築する際には、ユーザはディスプレイ３に表示された部品集テーブル５１中の構成部品一覧から所望の部品をマウス４の操作によって１つづつ選択し、表示画面上で接続する操作を行う。従って、各構成部品の接続関係は、画面上における配置位置によって一意に判

明する。この配置位置が各構成部品の接続関係を示すデータとして前記仮想システム保持テーブル５６に登録され、整理番号を指定することによって該当する整理番号の仮想ＬＡＮに関するデータが仮想システム保持テーブル５６から読み出され、ディスプレイ３の表示画面上に再生される。

【００４１】稼働状況シミュレータ処理（ＭＴＢＦ算出手段）１２は、仮想ＬＡＮ構成部品のいずれか１つをランダムに選出し、その選出部品の故障率と乱数によって生成した仮想故障率とを比較し、仮想故障率の方が小さい場合は選出部品に障害が発生したものと見做し、障害回数カウント値を更新する処理を所定回数繰返す第１の処理と、所定回数に達した時点での前記障害回数カウント値に基づいてＭＴＢＦを算出すると共に、仮想ＬＡＮ構成部品の全ての故障率を各構成部品の劣化率によって補正し、仮想システム保持テーブル５６中の構成部品の故障率を補正後の故障率に置換した後、前記第１の処理に引き継ぐ処理をユーザの設定回数分繰返し、ユーザの設定回数分繰り返した時点で各繰返し単位別のＭＴＢＦを出力するす第２の処理とを行うものである。

【００４２】トラブルシューティング処理１３は、仮想ＬＡＮ構成部品のいずれか１つをランダムに選出し、その選出部品の故障率と乱数によって生成した仮想故障率とを比較し、仮想故障率が小さい場合は選出部品に障害が発生したものと見做し、その選出部品の故障現象および故障原因ならびに偽故障原因の内容を故障現象一覧テーブル５３，故障原因一覧テーブル５４およびダミー故障原因一覧テーブル５５からランダムに取得して表示画面に表示させ、さらに表示された故障現象に対し、ユーザが回答した故障原因が正解か否かを判定し、判定結果のメッセージを出力するものである。

【００４３】次に、図８，図１０、図１２、図１４のフローチャートに基づいて、本実施形態のＬＡＮシミュレータの動作について説明する。

【００４４】まず、本シミュレータは、起動直後に、ディスプレイ３の表示画面に図９に示すようなＬＡＮシミュレータメニュー９０１を表示する。

【００４５】そこで、利用者は、キーボード２を使用してメニュー画面９０１の処理番号入力領域９０１に処理番号を入力することによって希望する処理を起動する（ステップ８０１）。コンピュータ１は、キーボード２によりメニュー画面９０１の処理番号入力領域９０２に入力された処理番号に対し、ステップ８０５およびステップ８０８の入力番号判定処理により、入力された処理番号が‘１’の場合は「仮想ＬＡＮシステム構築処理」１１を起動し（ステップ８１１）、入力された処理番号が‘２’の場合は「稼動状況シミュレーション処理」１２を起動し（ステップ８１０）、また入力された処理番号が‘３’の場合は「トラブルシューティングシミュレーション処理」１３を起動する（ステップ８０９）。

【００４６】この場合、入力された処理番号が「１」，「２」，「３」のいずれでもない場合は、ステップ８０２の入力データチェック処理およびステップ８０３の入力エラーかの判定処理によってステップ８０７に進み、メニュー画面９０１のメッセージ表示領域９０３にエラーメッセージを表示し、利用者に処理番号の再入力を促す。

【００４７】また、仮想ＬＡＮシステム構築以前に処理番号‘２’、‘３’が選択された場合も、ステップ８０６の「仮想ＬＡＮ構築済み？」の判定処理によってステップ８０７に進み、メニュー画面９０１のメッセージ表示領域９０３にエラーメッセージを表示し、利用者に仮想ＬＡＮシステムの構築を促す。以下、選択された処理の各々について順次説明してゆく。

【００４８】利用者によって処理番号‘１’が選択され、「仮想ＬＡＮシステム構築処理」１１が起動された場合、図１１に示すような仮想ＬＡＮ構築画面１１０１がディスプレイ３に表示される。

【００４９】図１０に、仮想ＬＡＮ構築処理１１の詳細をフローチャートで示している。

【００５０】利用者は、所望の構成部品から構成された所望のＬＡＮをディスプレイ３の表示画面上で構築するために、図１１の仮想ＬＡＮ構築画面１１０１で部品呼び出し操作を行う。例えば、キーボード２よってＰＦ１キー操作を行う（ステップ１０１１）。しかし、完了操作が行われた場合、ステップ１０１２の判定処理によって図８に戻る。

【００５１】ＰＦ１キー操作が行われた場合、部品呼び出し操作が行われたものとステップ１０１３の判定処理によって判定され、ステップ１０１４に進む。このステップ１０１４では、部品集テーブル５１から所望の仮想ＬＡＮを構築するために必要な複数の構成部品データを取り出し、図２に示した部品集表示画面２０１を表示する。

【００５２】部品集表示画面２０１に表示される部品は、アイコン形式で表示されるので、利用者がマウス４を使用して所望の部品アイコンを選択すると、その部品アイコンに割り当てられた部品番号を取得し（ステップ１０１５）、その部品番号を検索キーとして部品特性一覧テーブル５２を検索し（ステップ１０１６）、利用者が選択した部品の特性データ（部品番号３０１、名称３０２、故障率３０３、劣化率３０４、現象総数３０５）を取得する（ステップ１０１７）。そして、部品が選択された順番を整理番号７０１として、コンピュータ１の主メモリのワークエリアに退避する（ステップ１０１８）。

【００５３】利用者は、上記の操作を、必要とする構成部品の数に等しい回数だけ繰返し、仮想ＬＡＮシステム構築に必要な部品をすべて選択し終えたならば、その時点で完了操作（例えばキーボード２によってＰＦ９キー

操作）を行う。すると、ステップ１０１９の判定処理により、ステップ１０２０のエラーチェック処理およびステップ１０２１のエラー判定処理を経てワークエリアに退避しておいた特性データを仮想システム保持テーブル５６に登録する（ステップ１０２２）。

【００５４】この場合、ステップ１０２０のエラーチェック処理では、仮想ＬＡＮシステム構築に必ず必要な部品が欠落していないかチェックを行い、欠落が有る場合は、図１２の仮想ＬＡＮシステム構築画面１１０１のメッセージ表示領域１１０３にエラーメッセージを表示する(ステップ１０２３）。

【００５５】また、必要な部品アイコンを選択し、その部品アイコンを仮想ＬＡＮシステム作成領域１１０２の所望の位置に配置すると、その部品アイコンがその位置に固定される。そして、次の部品アイコンを選択し、所望の位置に配置し、ケーブルアイコンで接続するという操作によって所望の部品で構成された仮想ＬＡＮシステムをディスプレイ３の表示画面上で構築し、その構成部品の特性データを仮想システム保持テーブル５６に登録することができる。

【００５６】なお、部品集画面２０１は仮想ＬＡＮシステム作成領域１１０２の周縁部に表示される。

【００５７】また、特性データの格納完了時点、または取り消し操作（例えばキーボード２によってＰＦキー操作）を行うことにより処理を図９のメニュー画面９０１に戻すことができる。

【００５８】次に、メニュー画面９０１で処理番号‘２’の「稼動状況シミュレーション処理」１２が選択された場合の動作について図１２のフローチャートを参照して説明する。

【００５９】稼動状況シミュレーション処理１２が起動されると、まず、ディスプレイ３に図１３に示すような稼動状況シミュレーション画面１３０１を表示する。

【００６０】そこで、利用者は、この稼動状況シミュレーション画面１３０１の稼動年数入力領域１３０２に稼動年数を入力する（ステップ１２０１）。この入力操作は、例えばキーボード２よって「１」～「９」の整数値を入力することによって仮想ＬＡＮシステムを稼動させる稼動年数を入力する。このとき、入力された稼動年数が規定範囲外（例えば１～９以外）の場合は、稼動状況シミュレーション画面１３０１のメッセージ表示領域１３０３にエラーメッセージを表示して稼動年数の再入力を促す。

【００６１】入力された稼動年数が規定範囲内の場合は、仮想システム保持テーブル５６から仮想ＬＡＮシステムの特性データ（整理番号７０１、部品番号７０２、名称７０３、故障率７０４、劣化率７０５、現象総数７０６）をコンピュータ１内のメモリに読み込む。その後、稼動状況シミュレーション画面１３０１のメッセージ表示領域１３０３に「準備完了メッセージ」を表示し、利用者のシミュレーション開始操作を待つ。

【００６２】利用者は、「準備完了メッセージ」の表示後、開始操作（例えばキーボード１１によってＰＦ９キー操作)によって稼動状況シミュレーションを開始する。

【００６３】稼動状況シミュレーションは、以下の手順（１モンテカルロステップと呼ぶ）を例えば１００００回（１００×１００回）繰返し、その中で発生した障害件数及びＭＴＢＦの年別のモンテカルロ平均値<;ＭＴＢＦ>;及び標準偏差<;sd>;を後述する「数式５」及び「数式６」に示す計算式で計算することにより実行する。

【００６４】なお、以下の説明では、１モンテカルロステップを「３６５×２４」回の繰返しサイクルで構成し、これを稼動年数分繰り返すものとする。

【００６５】ここで、１モンテカルロステップ当たりの故障間隔の定義と平均故障間隔ＭＴＢＦの計算式について説明しておく。

【００６６】Ｍ回のループから成る１モンテカルロステップ内で、ｋ回の故障が発生したとすると、ｋ－１個の故障間隔Ｔｂ（ｉ）（但し、１≦ｉ≦ｋ－１）が観測される。

【００６７】モンテカルロループの（　）内の変数の初期値をＬ（ψ）（但し、Ｌ（ψ）＝１とし、ｊ回目の故障が発生した時点のループ変数の値をＬ（ｊ）（但し、１≦ｊ≦ｋ－１）とすると、故障間隔Ｔｂ（ｉ）は次の数式３で定義される。

【００６８】

【数３】

$$T_{B(j)} \equiv L_{(j)} - L_{(j-1)} \quad (1 \leqq j \leqq K-1)$$

【００６９】この時、１モンテカルロステップ当たりのＭＴＢＦは、次の数式４で定義される。

【００７０】

【数４】

$$MTBF = \frac{1}{K-1} \sum_{j=1}^{K-1} T_{B(j)}$$

【００７１】次に、Ｓ個のモンテカルロステップから成るモンテカルロシミュレーションで、各ｉ番目のステップで観測された平均故障間隔をＭＴＢＦ（ｉ）（但し、１≦ｉ≦Ｓ）とすると、平均故障間隔のモンテカルロ平均値<;ＭＴＢＦ>;及び標準偏差<;sd>;は、次の数式５，数式６で算出される。

【００７２】

【数５】

$$\langle MTBF \rangle = \frac{1}{S} \sum_{i=1}^{S} MTBF_{(i)}$$

【００７３】

【数６】

$$\langle sd\rangle = \sqrt{\frac{1}{S}\sum_{i=1}^{S}\left(MTBF_{(i)} - \langle MTBF\rangle\right)^2}$$

【００７４】図１２において、まず、ｑ個の障害カウンタ変数を準備して初期値を「０」にする（ステップ１２０１）。ここで、ｑは、仮想ＬＡＮシステムを構成する部品の総数を表す。

【００７５】次に、ステップ１２０２～１２０７の処理を「３６５×２４」回繰り返す。

【００７６】まず、ステップ１２０３では、〔１，ｑ〕の一様整数乱数Ｒ１を発生させる。そして、所定のタイミングで取得した乱数Ｒ１を故障が発生する部品の整理番号とし、その整理番号を検索キーとして、コンピュータ１のメモリに読み込んだ仮想ＬＡＮシステムの該当部品の故障率７０４（以下、簡単化のためＰと表現する）を取得する。すなわち、乱数Ｒ１によって仮想ＬＡＮシステムを構成する部品の１つをランダムに選出する。

【００７７】次に、〔０，１〕の一様実数乱数Ｒ２を発生させる。この乱数Ｒ２は、各部品の故障率の比較基準になるものである。この乱数Ｒ２を所定のタイミングで取得し、ランダムに選出した部品の故障率Ｐと比較し、Ｒ２＜Ｐならば、その選出部品が故障したものと見做し、ステップ１２０４の判定を経てステップ１２０５に進む。Ｒ２＞Ｐならば、故障発生とせず、ステップ１２０２に戻る。

【００７８】ステップ１２０５では、乱数Ｒ１に対応するＲ１番目の障害カウンタの値を「１」だけカウントアップする。

【００７９】次に、ステップ１２０６では、数式３で示したように前回故障発生時の稼動年数ループカウンタと現在の稼動年数ループカウンタの差分を故障間隔として計算する。

【００８０】次にステップ１２０８では、稼動年数ループカウンタの値が「３６５×２４」の整数倍になったら、ステップ１２０５で求めた障害件数の集計を行い、更にステップ１２０６で求めた故障間隔から年別に数式４に基づいて計算することにより、１モンテカルロステップ当たりのＭＴＢＦを計算する。

【００８１】また、数式２の劣化率の定義から現在の故障率と劣化率をもとに、各部品の故障率を再計算し、その再計算結果の故障率を以降において使用する故障率とする。すなわち、コンピュータ１のメモリに格納した仮想ＬＡＮシステムの各部品の故障率７０４を再計算結果の故障率に置換する。

【００８２】次にステップ１２１０では、「３６５×２４×稼動年数」個の１モンテカルロステップ当たりのＭＴＢＦから数式５に基づいて、年別にモンテカルロ平均値<;ＭＴＢＦ>;と標準偏差<;sd>;を求め、同様に障害件数の年別平均値を求める。

【００８３】発生した障害件数の平均値及び<;ＭＴＢＦ>;と<;sd>;の計算が完了したら、計算結果の<;ＭＴＢＦ>;を稼動状況シミュレーション画面１３０１のＭＴＢＦ表示領域１３０４に年別に表示し、また誤差表示領域１３０５に年別に標準偏差<;sd>;を表示し、さらに障害発生件数表示領域１３０６に障害件数の年別平均値を表示する。

【００８４】利用者が終了操作（例えばキーボード２によってＰＦ１１キー操作）することにより、メニュー画面９０１に戻る。

【００８５】次に、メニュー画面９０１で処理番号‘３’の「トラブルシューティングシミュレーション処理」１３が選択された場合の動作について図１４のフローチャートを参照して説明する。

【００８６】トラブルシューティングシミュレーション処理１３が起動されると、図１５に示すようなトラブルシューティングシミュレーション画面１５０１が表示される。

【００８７】コンピュータ１は、まず、トラブルシューティングシミュレーション画面１５０１の表示後、仮想システムテーブル５６内の仮想ＬＡＮシステムの構成部品の特性データをコンピュータ１内部のメモリに読み込む。

【００８８】そこで、利用者が終了操作（例えばキーボード２によってＰＦキー操作）を行って処理をメニュー画面９０１に戻すまで、以下の手順を行って利用者の入力を待つ。

【００８９】利用者がキーボード２のキー操作によってトラブルシューティングシミュレーション開始の指示を行った場合、最初にステップ１４０５～１４０９の処理によってテスト問題を作成する。

【００９０】ステップ１４０５では、［１，ｑ］の一様整数乱数Ｒ１を発生させる。ｑは仮想ＬＡＮシステム構成部品の総数である。そして、この乱数Ｒ１を所定のタイミングで取得し、故障が発生する部品の整理番号とする。そして、その整理番号を検索キーとして、コンピュータ１内部のメモリに読み込んだ仮想ＬＡＮシステム構成部品の故障率７０４（以下、簡単化のためＰと記述する）、現象総数７０６（以下，簡単化のためＭと記述する）を取得する。

【００９１】次にステップ１４０６では、［０，１］の一様実数乱数Ｒ２を発生させる。そして、所定のタイミングで取得した乱数Ｒ２と故障率Ｐの大小判定を行うことで故障発生の有無を吟味する。Ｒ２＜Ｐならば故障発生と見做し、ステップ１４０７へ進む。それ以外の場合は、故障発生とせずステップ１４０５に戻る。

【００９２】ステップ１４０７では、［１，Ｍ］の一様整数乱数Ｒ３を発生させる。Ｍはステップ１４０５で取得した現象総数である。そして、その乱数Ｒ３を発生し

た現象のシーケンス番号とし、このシーケンス番号Ｒ３と部品番号Ｒ１とを検索キーとしてコンピュータ１内部のメモリに存在する故障現象一覧（図４）を検索し、現象内容４０３を取得する。次に同様に、部品番号Ｒ１とシーケンス番号Ｒ３を検索キーとしてコンピュータ１内部のメモリに存在する故障原因一覧（図５）を検索し、原因要約５０３、詳細説明５０４を取得する。

【００９３】次にステップ１４０８では、ステップ１４０７と同様にして部品番号Ｒ１とシーケンス番号Ｒ３を検索キーとしてコンピュータ１内部のメモリに存在するダミー故障原因一覧（図６）を検索し、ダミー部品番号（１）６０３、（２）６０４)、ダミーシーケンス（１）６０５、（２）６０６を取得する。

【００９４】次に、その取得したダミー部品番号（１）６０３、（２）６０４)、ダミーシーケンス（１）６０５、（２）６０６を検索キーとして原因要約５０３を取得する。

【００９５】次に、ステップ１４０９では、トラブルシューティングシミュレーション画面１５０１の現象表示領域１５０３にステップ１４０７で取得した現象内容４０３を表示する。次に、トラブルシューティングシミュレーション画面１５０１の原因表示領域１５０４にステップ１４０７で取得した原因要約５０３とステップ１４０８で取得したダミー原因の要約とをシーケンス番号の昇順に表示する。

【００９６】これによって、利用者自身が構築した仮想ＬＡＮシステムを基にしたテスト問題が作成され、利用者に提示される。この段階で、トラブルシューティングシミュレーション処理１３は、利用者からの回答待ちとなる。

【００９７】そこで、利用者が回答操作、例えばキーボード２における「１」～「３」の整数値入力によって現象に対する回答をトラブルシューティングシミュレーション画面１５０１の回答入力領域１５０５に入力すると、トラブルシューティングシミュレーション処理１３は、この入力された回答が正解か否か吟味し（ステップ１４０３，１４１２）、正解ならば正解メッセージをトラブルシューティングシミュレーション画面１５０１のメッセージ表示領域１５０２に表示し（ステップ１４１３）、誤答ならばエラーメッセージをメッセージ表示領域１５０２に表示する（ステップ１４１４）。

【００９８】ここで、利用者が解説操作、例えばキーボード２におけるＰＦ９キー操作を行った場合、（ステップ１４１０）、図１６に示す解説画面１６０１を表示する(ステップ１４１１）。また、出題操作、例えばキーボード２におけるＰＦ８キー操作を行った場合（ステップ１４０４）、ステップ１４０５に戻る。

【００９９】また、終了操作、例えばキーボード２におけるＰＦ１１キー操作を行った場合、処理をメニュー画面９０１に戻す。

【０１００】なお、解説画面１６０１では、ステップ１４０７で取得した原因要約及び詳細説明を原因表示領域１６０２及び詳細説明表示領域１６０３に表示する。

【０１０１】以上のように、本実施形態によれば、コンピュータ内部に仮想のネットワークを構築し、その仮想ネットワーク構成部品のいずれか１つをランダムに選出し、その選出部品の故障率と乱数によって生成した仮想故障率とを比較し、仮想故障率が小さい場合は選出部品に障害が発生したものと見做し、障害回数カウント値を更新する処理を所定回数繰返し、所定回数に達した時点での障害回数カウント値に基づいてＭＴＢＦを算出すると共に、仮想ネットワーク構成部品の全ての故障率を各構成部品の劣化率によって補正する処理を、ユーザの設定回数分繰返し、ユーザの設定回数分繰り返した時点で各繰返し単位別のＭＴＢＦを出力するようにしたため、１モンテカルロステップの回数として、例えば、１年を１時間単位で区分した値「３６５×２４＝８７６０」に設定すれば、１モンテカルロステップを１回繰り返すことによって稼働開始から１年経過後のＭＴＢＦが得られる。

【０１０２】これによって、構成部品の経年変化を含めたネットワークシステムの信頼性をＭＴＢＦ等の数値で速やかに提示し、管理業務を支援することができる。

【０１０３】また、サーバマシン等を２重化した場合としない場合との定量的な比較を簡単に行うことができるため、２重化したことによる経済的な無駄等を定量的に把握することが可能になる。

【０１０４】また、構築された仮想ネットワーク構成部品のいずれか１つをランダムに選出し、その選出部品の故障率と乱数によって生成した仮想故障率とを比較し、仮想故障率が小さい場合は選出部品に障害が発生したものと見做し、その選出部品の故障現象および故障原因ならびに偽故障原因の内容を故障現象一覧テーブル，故障原因一覧テーブルおよびダミー障原因一覧テーブルからランダムに取得して表示画面に表示することによって原因と現象に関するテスト問題を出題し、その出題無いように対する回答を入力させることによって正解か否かを判定し、判定結果のメッセージを出力するようにしているため、ネットワーク管理者を速やかに効率良く養成することが可能になる。

【０１０５】なお、上記実施形態においては、仮想ＬＡＮシステムを構築してＭＴＢＦを算出する例を挙げて説明したが、本発明は、これに限定されるものではなく、ＷＡＮなどの各種のネットワークのシミュレーションに適用できるものである。この場合、各種のテーブルの内容はネットワークシステムの規模や種類、特徴に応じて適切なものに設定されることは言うまでもない。

【０１０６】

【発明の効果】以上の説明から明らかなように、本発明によれば、構成部品の経年変化を含めたネットワークシ

ステムの信頼性をＭＴＢＦ等の数値で速やかに提示し、管理業務を支援することができる。

【０１０７】また、サーバマシン等を２重化した場合としない場合との定量的な比較を簡単に行うことができるため、２重化したことによる経済的な無駄等を定量的に把握することが可能になる。

【０１０８】さらに、ネットワーク管理者を速やかに効率良く養成することが可能になる。

【図面の簡単な説明】

【図１】本発明を適用したＬＡＮシミュレータの実施形態を示すシステム構成図である。

【図２】部品集の画面表示例を示す図である。

【図３】部品特性一覧テーブルの構成図である。

【図４】故障現象一覧テーブルの構成図である。

【図５】故障原因一覧テーブルの構成図である。

【図６】ダミー故障原因一覧テーブルの構成図である。

【図７】仮想システム保持テーブルの構成図である。

【図８】複数の機能を選択する処理過程を示すフローチャートである。

【図９】ＬＡＮシミュレータメニュー画面の表示例を示す図である。

【図１０】仮想ＬＡＮシステム構築処理を示すフローチャートである。

【図１１】仮想ＬＡＮシステム構築画面の表示例を示す図である。

【図１２】稼動状況シミュレーション処理を示すフローチャートである。

【図１３】稼動状況シミュレーション画面の表示例を示す図である。

【図１４】トラブルシューティングシミュレーション処理を示すフローチャートである。

【図１５】トラブルシューティングシミュレーション画面の表示例を示す図である。

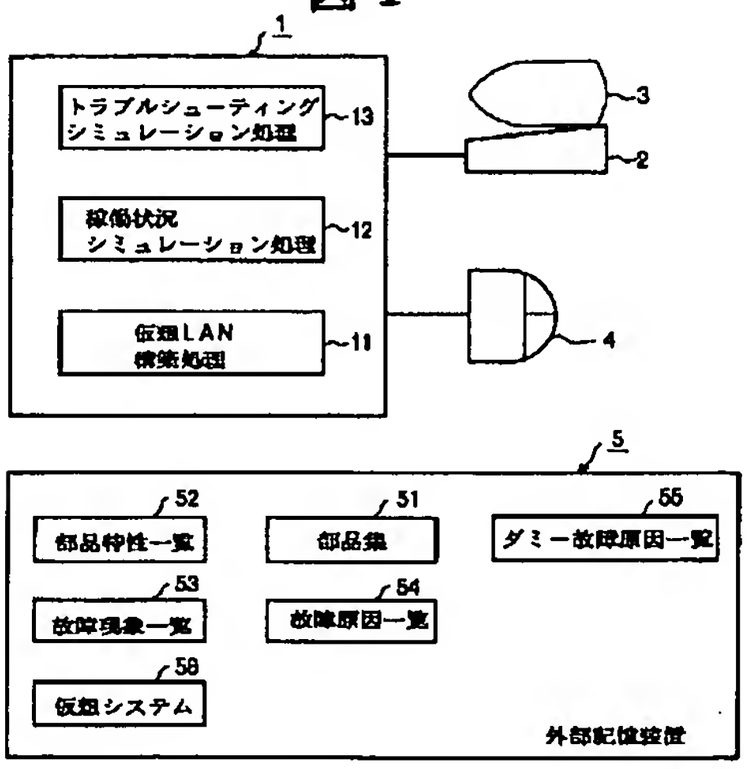
【図１６】解説画面の表示例を示す図である。

【符号の説明】

１…コンピュータ、２…キーボード、３…ディスプレイ、５…外部記憶装置、１１…仮想ＬＡＮ構築装置、１２…稼働状況シミュレーション処理、１３…トラブルシューティングシミュレーション処理、５２…部品特性一覧テーブル、５３…故障現象一覧テーブル。

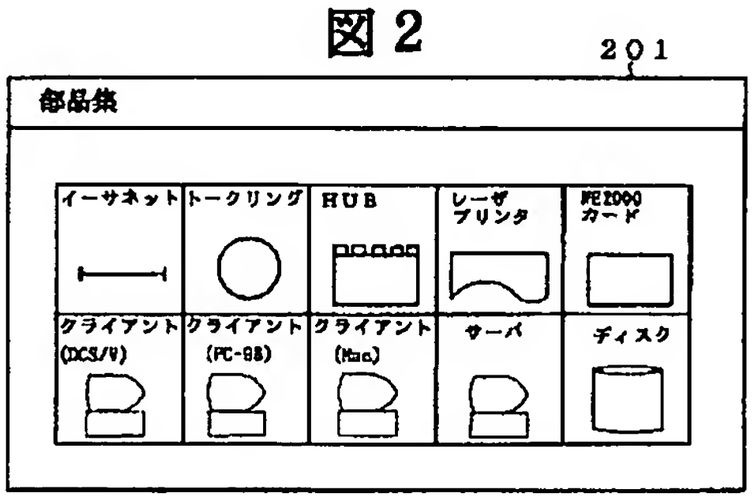
【図１】

図 1



【図２】

図 2



【図３】

図 3

部品特性一覧

301 部品番号	302 名　称	303 故障率	304 劣化率	305 現象総数
1	イーサーネット	0．10	5	500
2	トークンリング	0．12	4	300
3	HUB	0．20	10	400

【図４】

図 4

故障現象一覧

401 部品番号	402 シーケンス番号	403 現　象　内　容
1	1	一斉ログオンするとレスポンスが悪化する
1	2	ネットワーク全体がダウンした

【図5】

図5

故障原因一覧

501 部品番号	502 シーケンス番号	503 原因要約	504 詳細説明
1	1	回線過負荷	回線容量に比較しトラフィックが…
1	2	回線切断	回線の物理的切断により…
1	3	ターミネータ不良	ターミネータがはずれたため…

【図6】

図6

ダミー故障原因一覧

601 部品番号	602 シーケンス番号	603 ダミー部品番号1	604 ダミー部品番号2	605 ダミーシーケンス1	606 ダミーシーケンス2
1	1	2	3	1	2
2	1	3	4	2	1
3	1	4	5	3	2

【図7】

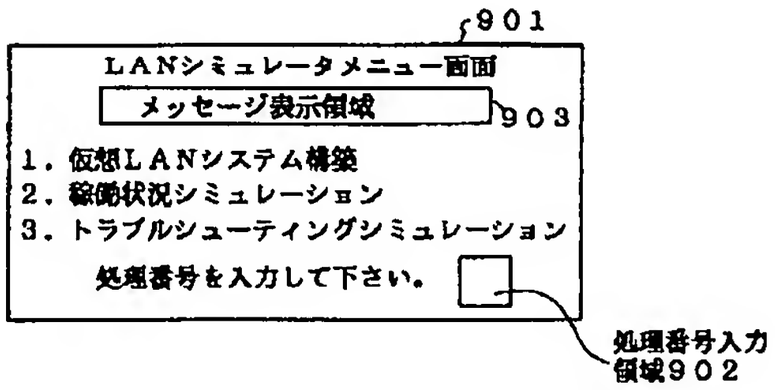
図7

仮想システム

701 整理番号	702 部品番号	703 名　称	704 故障率	705 劣化率	706 現象総数
1	1	イーサーネット	0.10	5	500
2	6	クライアント(DOS/V)	0.40	30	1000
3	10	サーバ	0.60	30	800

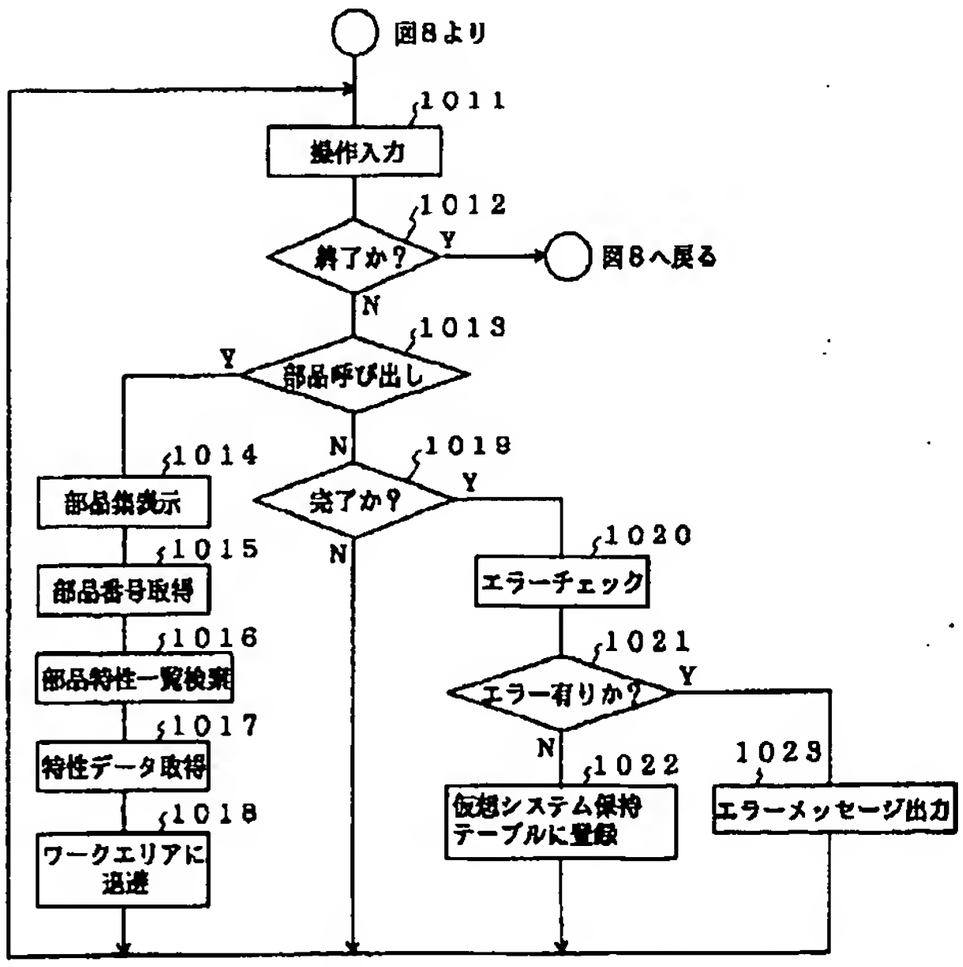
【図9】

図9



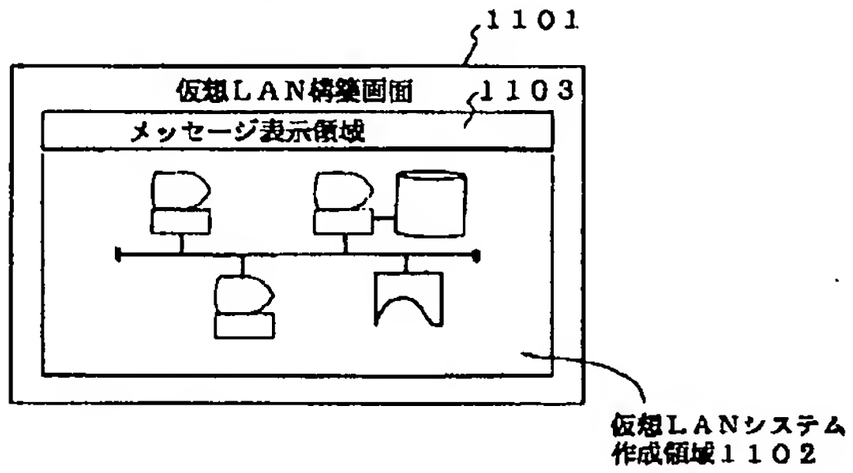
【図10】

図10



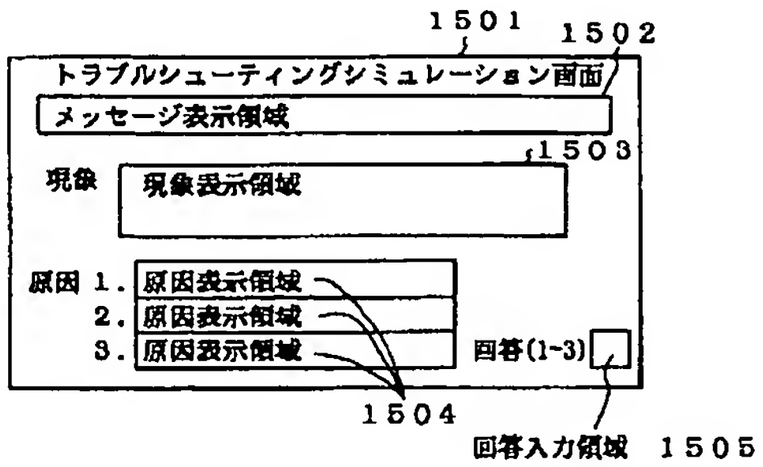
【図11】

図11



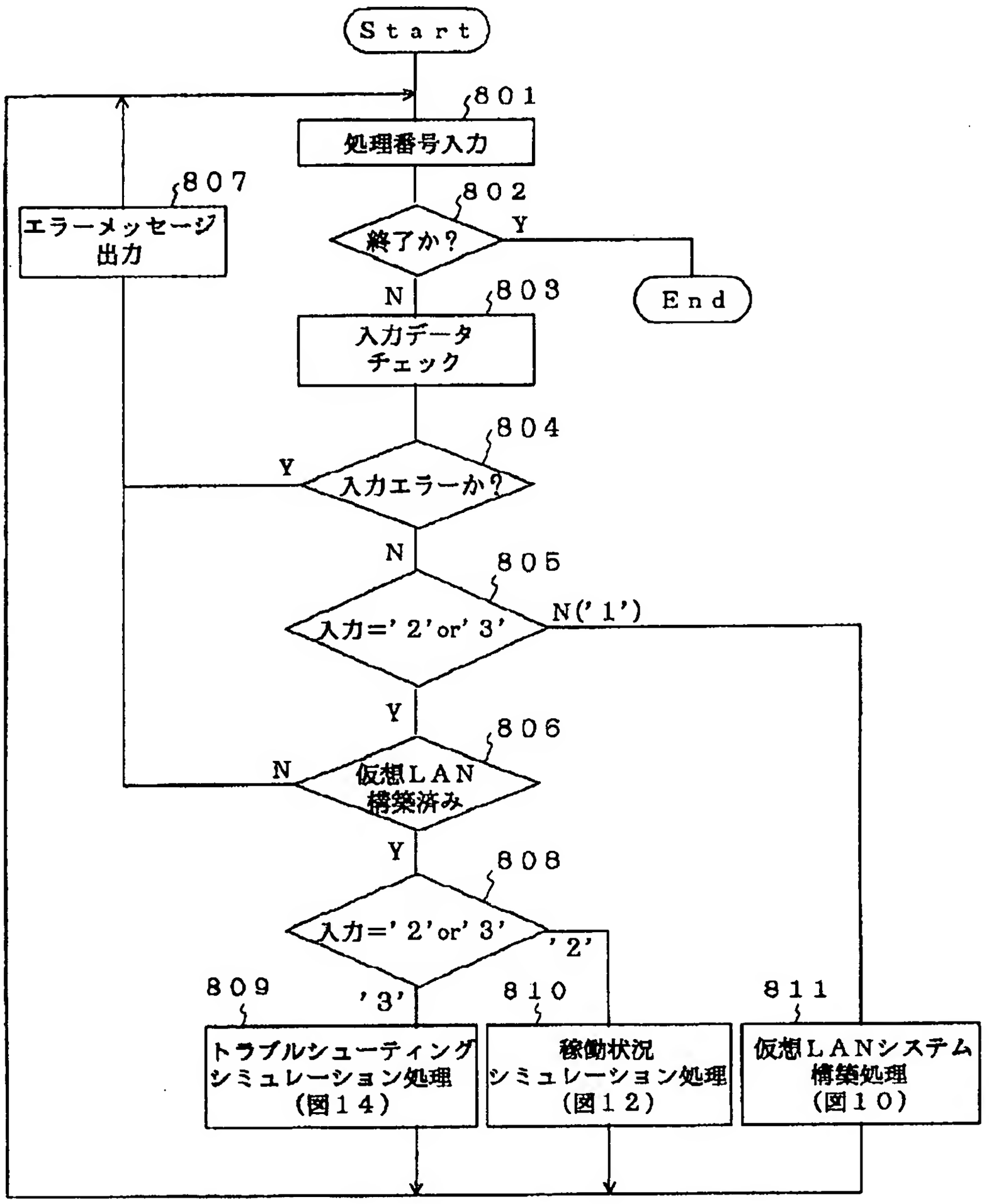
【図15】

図15



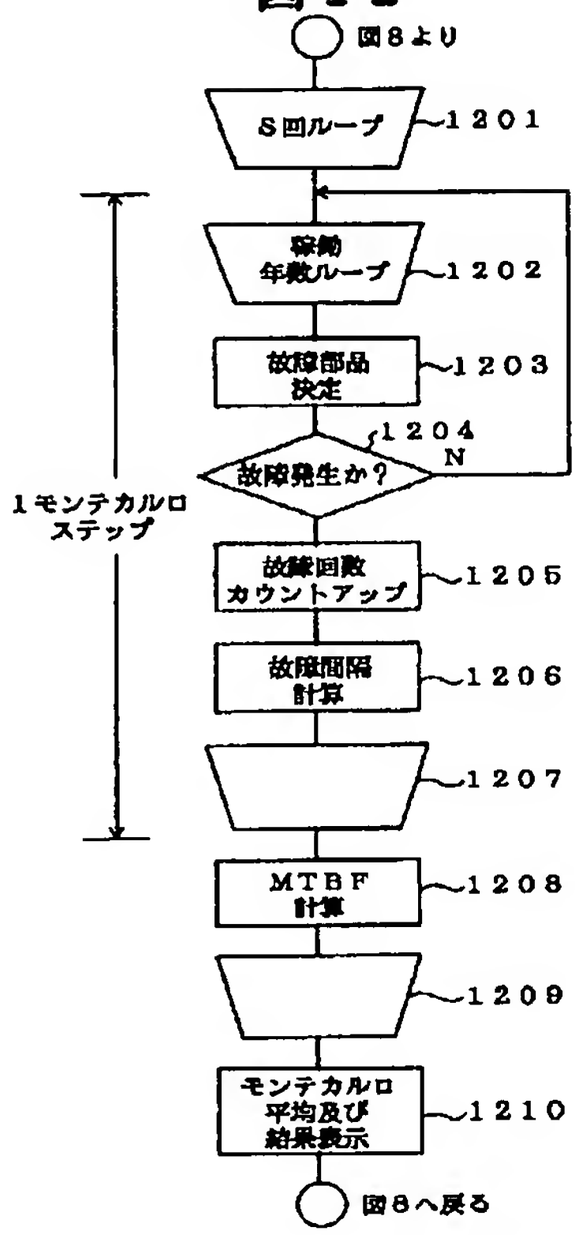
【図8】

図8


Start
801
処理番号入力
802
終了か？
Y
End
N
803
入力データ
チェック
804
入力エラーか？
Y
N
805
入力＝'2'or'3'
N('1')
Y
806
仮想ＬＡＮ
構築済み
N
Y
808
入力＝'2'or'3'
'2'
809
'3'
810
811
807
エラーメッセージ
出力
トラブルシューティング
シミュレーション処理
（図１４）
稼働状況
シミュレーション処理
（図１２）
仮想ＬＡＮシステム
構築処理
（図１０）

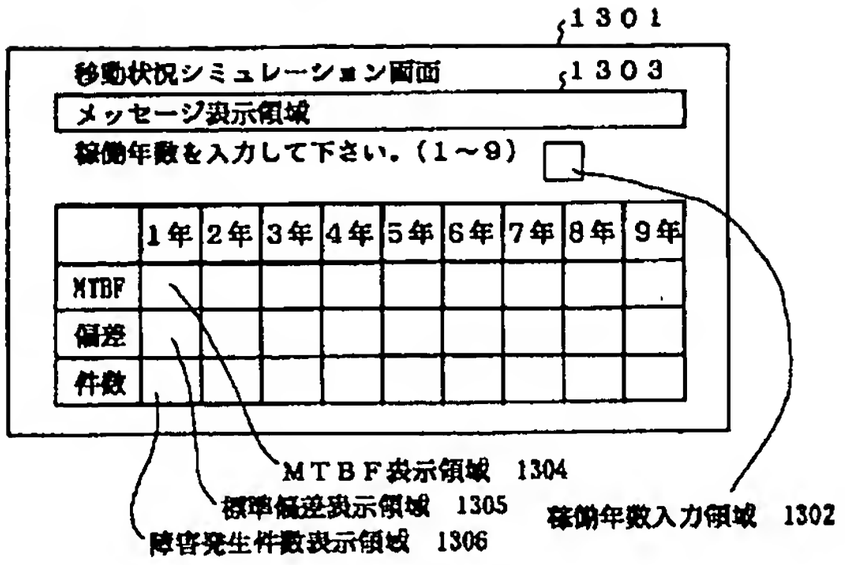
【図１２】

図１２



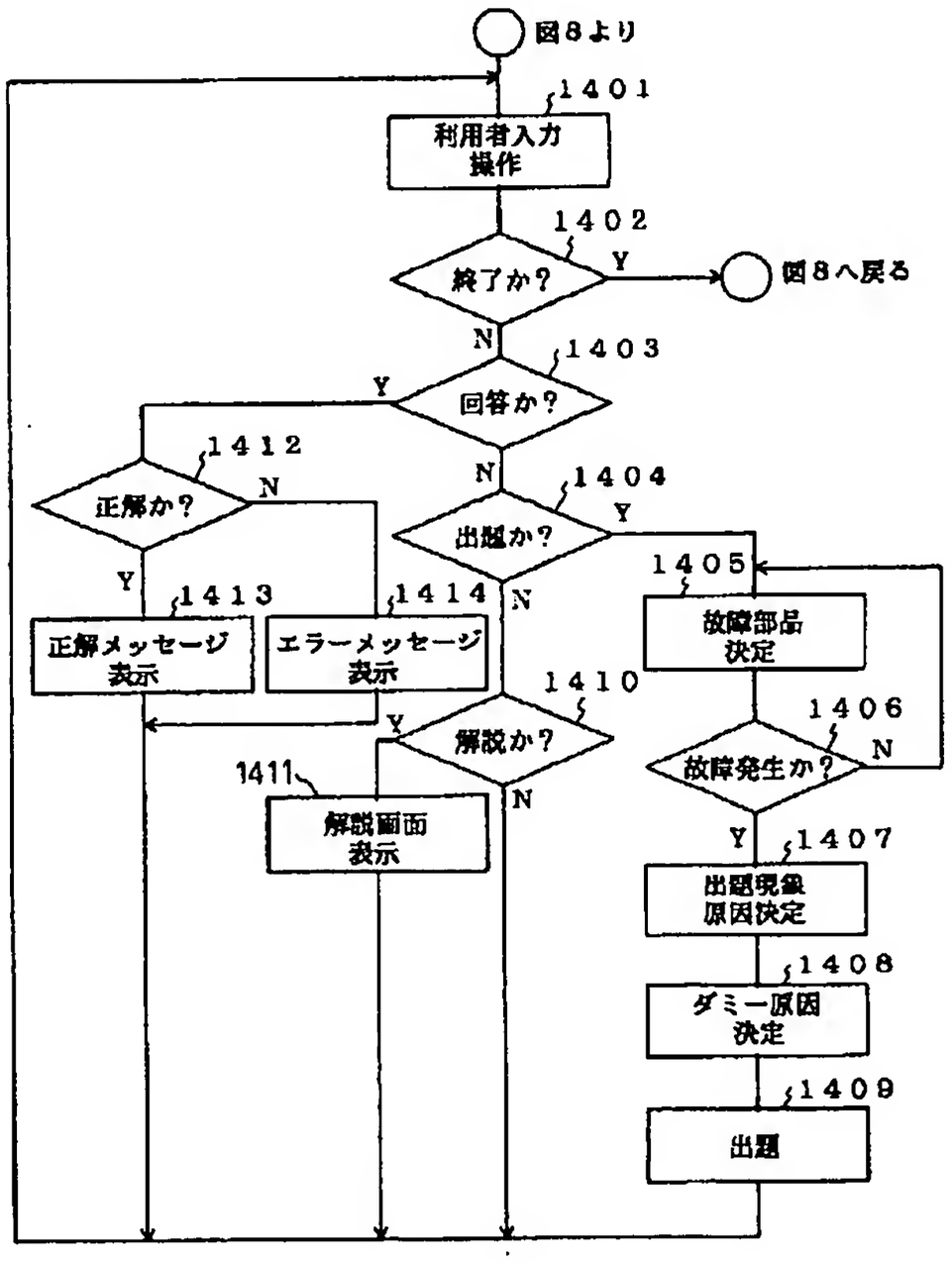
【図１３】

図１３



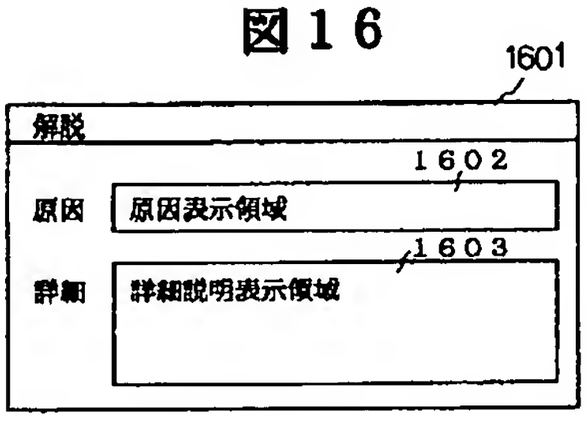
【図１４】

図１４



【図１６】

図１６



* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The component part table which memorized the data of two or more component parts which are needed when building a network, The components property list table which memorized the property data containing the failure rate of each component part, and the rate of degradation accompanying secular change, A virtual network construction means to connect the data of the component part which the user specified among the data of the component part of said component part table by the connection relation specified by a user, and to build the network of imagination inside a computer, A maintenance means to acquire the property data of the component part which constitutes the built virtual network from said components property list table, and to hold as a virtual network component part property data list, Elect at random [a virtual network component part / any one], and the failure rate of the election component is compared with the virtual failure rate generated with the random number. The 1st processing which repeats the processing which regards it as what the failure generated on election components when a virtual failure rate is small, and updates the count counted value of a failure the number of predetermined times, While computing MTBF based on said count counted value of a failure in the time of becoming the count of predetermined The rate of degradation of each component part amends all the failure rates of a virtual network component part. After permuting by the failure rate after amending the failure rate of the component part in said maintenance means, The network simulator characterized by having an MTBF calculation means to perform 2nd processing which outputs MTBF according to each repeating unit when the processing taken over to said 1st processing is repeated by a user's predetermined number and repeated by a user's predetermined number.
[Claim 2] The component part table which memorized the data of two or more component parts which are needed when building a network, The components property list table which memorized the property data containing the failure rate of each component part, and the rate of degradation accompanying secular change, The failure phenomenon list table which memorized the contents of the failure phenomenon according to the phenomenon about each of each component part, The cause-of-fault list table which memorized the contents of the cause of fault corresponding to each of said failure phenomenon about each of each component part, The fake cause-of-fault list table which memorized the contents of the cause of fault of the false corresponding to each of said failure phenomenon about each of each component part, A virtual network construction means to connect the data of the component part which the user specified among the data of the component part of said component part table by the connection relation specified by a user, and to build the network of imagination inside a computer, A maintenance means to acquire the property data of the component part which constitutes the built virtual network from said components property list table, and to hold as a virtual network component part property data list, Elect at random [a virtual network component part / any one], and the failure rate of the election component is compared with the virtual failure rate generated with the random number. It is regarded as what the failure generated on election components when a virtual failure rate was small. The contents election means of setting a problem which acquires the contents of the failure phenomenon of the election component, a cause of fault, and the fake cause of fault from said failure phenomenon list

table, a cause-of-fault list table, and a fake cause-of-fault list table at random, and is displayed on the display screen, The network simulator characterized by having a judgment means by which the cause of fault which the user answered judges whether it is a correct answer, and outputs the message of a judgment result, to the displayed failure phenomenon.

[Claim 3] The component part table which memorized the data of two or more component parts which are needed when building a network, The components property list table which memorized the property data containing the failure rate of each component part, and the rate of degradation accompanying secular change, Virtual network construction processing in which connect the data of the component part which the user specified among the data of the component part of said component part table by the connection relation specified by a user, and the network of imagination is built inside a computer, A maintenance means to acquire the property data of the component part which constitutes the built virtual network from said components property list table, and to hold as a virtual network component part property data list, Elect at random [a virtual network component part / any one], and the failure rate of the election component is compared with the virtual failure rate generated with the random number. The 1st processing which repeats the processing which regards it as what the failure generated on election components when a virtual failure rate is small, and updates the count counted value of a failure the number of predetermined times, While computing MTBF based on said count counted value of a failure in the time of becoming the count of predetermined The rate of degradation of each component part amends all the failure rates of a virtual network component part. After permuting by the failure rate after amending the failure rate of the component part in said maintenance means, MTBF calculation processing in which 2nd processing which outputs MTBF according to each repeating unit when the processing taken over to said 1st processing is repeated by a user's predetermined number and repeated by a user's predetermined number is performed, The storage for network simulations characterized by memorizing the program and table which can perform a ****** computer.

[Claim 4] The component part table which memorized the data of two or more component parts which are needed when building a network, The components property list table which memorized the property data containing the failure rate of each component part, and the rate of degradation accompanying secular change, The failure phenomenon list table which memorized the contents of the failure phenomenon according to the phenomenon about each of each component part, The cause-of-fault list table which memorized the contents of the cause of fault corresponding to each of said failure phenomenon about each of each component part, The fake cause-of-fault list table which memorized the contents of the cause of fault of the false corresponding to each of said failure phenomenon about each of each component part, Virtual network construction processing in which connect the data of the component part which the user specified among the data of the component part of said component part table by the connection relation specified by a user, and the network of imagination is built inside a computer, A maintenance means to acquire the property data of the component part which constitutes the built virtual network from said components property list table, and to hold as a virtual network component part property data list,

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the network simulator and the storage for network simulations which perform the exchange or the education of management business of a network administrator, such as LAN.
[0002]
[Description of the Prior Art] In recent years, a communication line is connected with a computer and the network system of various kinds of scales, such as LAN, WAN, etc. which made information, such as a document, and an image, voice, exchangeable between premises or a long distance point, is developed.
[0003] In such a network system, if the part used as nuclei, such as a server machine and a communication line, breaks down, the whole network or a part will become a serious situation, like employment becomes impossible.
[0004] Then, in the former, by duplex-izing a server, a disk, a communication line, etc., redundancy is given to a system and the measures which raise dependability are taken.
[0005] Moreover, it faces introducing the server machine and client machine which are a network component, and it is being considered that system-wide dependability becomes high by selecting what has a failure rate low as much as possible.
[0006] However, this kind of network system is equipped with the flexibility in which network devices, such as a client machine, are fluctuated if needed, as one description. For this reason, even if it integrates the failure rate of each components, such as a server machine, a client machine, and a communication line, and estimates a system-wide failure rate at the time of the beginning of mission of a network system, that estimate will change with the changes in a network device a lot.
[0007] Then, in the former, at every change in a network device, a system-wide failure rate is re-calculated by the help, and to grasp system-wide dependability by the count result is tried.
[0008]
[Problem(s) to be Solved by the Invention] However, when time amount and an effort are applied by the approach of re-calculating a system-wide failure rate and it requires emergency by the help, there is a problem that it cannot respond promptly.
[0009] Moreover, as a numeric value which shows dependability quantitatively, although there are numeric values, such as MTBF (Mean Time Between Failure) and an operating ratio, also in consideration of secular change, numeric values other than the failure rate of each component part, such as such MTBF, are calculated, and there is a problem that it cannot show promptly.
[0010] Furthermore, though dependability is raised by performing duplex-ization, since the absolute comparison of dependability with the case where it does not duplex-ize cannot be performed, there is a problem that possibility that gave improvement in dependability beyond the dependability demanded, and the futility of cost has arisen, and its condition of not filling demand dependability only with duplex-ization cannot be grasped, conversely.

[0011] on the other hand, the concept of the dependability of a network system is indefinite -- by 7, the network system was actually built, about acquisition of the management technique of the manager who manages this, conventionally, study with books and an actual management experience are cores, and great time amount and cost have started training of a manager. For this reason, educational system implementation which trains a new manager efficiently promptly in preparation for the case where reduction and the manager of cultivation cost take the place etc. is desired.
[0012] Made in order that this invention may solve such a problem, the 1st purpose presents promptly the dependability of a network system including secular change of a component part for numeric values, such as MTBF, and is to offer the network simulator and the storage for network simulations which can support management business.
[0013] The 2nd purpose of this invention enables trouble-shooting training, and is to offer the network simulator and the storage for network simulations which can train a network administrator efficiently.
[0014]
[Means for Solving the Problem] The component part table which memorized the data of two or more component parts which are needed when building a network in order that this invention may attain the 1st purpose of the above, The components property list table which memorized the property data containing the failure rate of each component part, and the rate of degradation accompanying secular change, A virtual network construction means to connect the data of the component part which the user specified among the data of the component part of said component part table by the connection relation specified by a user, and to build the network of imagination inside a computer, A maintenance means to acquire the property data of the component part which constitutes the built virtual network from said components property list table, and to hold as a virtual network component part property data list, Elect at random [a virtual network component part / any one], and the failure rate of the election component is compared with the virtual failure rate generated with the random number. The 1st processing which repeats the processing which regards it as what the failure generated on election components when a virtual failure rate is small, and updates the count counted value of a failure the number of predetermined times, While computing MTBF based on said count counted value of a failure in the time of becoming the count of predetermined The rate of degradation of each component part amends all the failure rates of a virtual network component part. After permuting by the failure rate after amending the failure rate of the component part in said maintenance means, When the processing taken over to said 1st processing is repeated by a user's predetermined number and repeated by a user's predetermined number, it is characterized by establishing an MTBF calculation means to perform 2nd processing which outputs MTBF according to each repeating unit.
[0015] If one year is set as the value "365x24=8760" classified by one time basis as a count of predetermined in the 1st processing here, MTBF after progress will be acquired by repeating the 1st processing once for one year.
[0016] Moreover, the component part table which memorized the data of two or more component parts which are needed when building a network in order to attain the 2nd purpose of the above, The components property list table which memorized the property data containing the failure rate of each component part, and the rate of degradation accompanying secular change, The failure phenomenon list table which memorized the contents of the failure phenomenon according to the phenomenon about each of each component part, The cause-of-fault list table which memorized the contents of the cause of fault corresponding to each of said failure phenomenon about each of each component part, The fake cause-of-fault list table which memorized the contents of the cause of fault of the false corresponding to each of said failure phenomenon about each of each component part, A virtual network construction means to connect the data of the component part which the user specified among the data of the component part of said component part table by the connection relation specified by a user, and to build the network of imagination inside a computer, A maintenance means to acquire the property data of the component part which constitutes the built virtual network from said components property list table, and to hold as a virtual network component part property data list, Elect at random [a virtual network component part / any one], and the failure rate of the election component is compared with the virtual failure rate

generated with the random number. It is regarded as what the failure generated on election components when a virtual failure rate was small. The contents election means of setting a problem which acquires the contents of the failure phenomenon of the election component, a cause of fault, and the fake cause of fault from said failure phenomenon list table, a cause-of-fault list table, and a fake cause-of-fault list table at random, and is displayed on the display screen, To the displayed failure phenomenon, the cause of fault which the user answered judges whether it is a correct answer, and is characterized by having a judgment means to output the message of a judgment result.

[0017]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is concretely explained using a drawing.

[0018] Drawing 1 is the system configuration Fig. showing the operation gestalt of the LAN simulator which applied this invention, and consists of a computer 1 and external storage 5, such as the keyboard 2 which is the input/output equipment, a display 3, a mouse (pointing device) 4, and a hardware disk.

[0019] In order to show promptly the dependability of a network system including secular change of network configuration components for numeric values, such as MTBF, to enable to support management business and trouble-shooting training and to train a network administrator efficiently, the virtual LAN construction processing 11, the system-operating-status simulator processing 12, and the trouble-shooting processing 13 are included in the interior of a computer 1 as an application program.

[0020] These the processings 11, 12, and 13 of each are memorized by storages, such as CD-ROM, in the data format which can perform a computer 1, and the user of a computer 1 is provided with them.

[0021] On the other hand, the collection table (component part table) 51 of components, the components property list table 52, the failure phenomenon list table 53, the cause-of-fault list table 54, the dummy cause-of-fault list table (fake cause-of-fault list table) 55, and the virtual-system maintenance table 56 are formed in external storage 5.

[0022] The collection table 51 of components memorized the data of two or more component parts which are needed when a user builds a desired virtual network, and as shown in drawing 2 , it has memorized the data for displaying component parts, such as Ethernet, a token ring, and a client machine, in an icon format.

[0023] As the components property list table 52 memorized the property data containing the failure rate of each component part, and the rate of degradation accompanying secular change and they shown to drawing 3 in it, it has the column of the part number 301 attached to component parts, such as Ethernet, the name 302 of a component part, a failure rate 303, the rate 304 of degradation, and the phenomenon total 305, and the name of component parts, such as Ethernet, the rate of failure rate degradation, and the phenomenon total are set as each column according to the part number.

[0024] Here, a failure rate is the failure probability of occurrence per hour of the components specified with the part number 301, and it defines by the count of failure per hour. That is, supposing T hours carries out N time failure, as Components n show the failure rate Pn of this component n in a formula (1), it defines.

[0025]

[Equation 1]

$$P_n \equiv \frac{N}{T}$$

[0026] The rate of degradation is an index showing the long term deterioration of the components specified with the part number 301, and it is the increment of the failure probability of occurrence for every progress, and will express by the percentage for one year. That is, if the failure rate after the operation during Pn (phi) and one year is set to Pn (1) for the failure rate at the time of the factory shipments of Components n, rate of degradation alphan will be defined by the formula (2).

[0027]

[Equation 2]

$$\alpha_n \equiv \left(\frac{P_{n(1)}}{P_{n(\phi)}} - 1 \right) \times 100$$

[0028] For example, the failure rate of a certain components is "0.5", and when the rate of degradation of this component is "20", it will be set to "0.5x (100+20) / 100= 0.6" if the failure rate of the next year of this component is calculated.
[0029] Moreover, a phenomenon total is a total of a phenomenon which appears when the component part of ****** specified with the part number 301 is breaking down, and it is set up based on an experience value. For example, "1" means that there is a phenomenon at the time of failure only in one kind in the phenomenon total.
[0030] The contents of the phenomenon of appearing when it has the column of the part number 401, a sequence number 402, and the contents 403 of a phenomenon and each component part breaks down, as the failure phenomenon list table 53 memorized the contents of the failure phenomenon according to a phenomenon about each of each component part and they shown to drawing 4 in it are memorized according to the sequence number.
[0031] A sequence number 402 is an identification number attached in order to distinguish two or more phenomena belonging to the same part number uniquely, and serves as a major key by two items, the part number 401 and a sequence number 402. A number is assigned sequentially from "1" within each part lot number number. The contents 403 of a phenomenon are the contents of the phenomenon generated to the LAN system, for example, "the whole network was downed" etc.
[0032] Here, the number of the contents of a phenomenon is equal to the value of the phenomenon total 305 of the components property list table 52. That is, all the contents of the phenomenon of appearing when each component part breaks down give a sequence number to this failure phenomenon list table 53, and are set to it.
[0033] As the cause-of-fault list table 54 memorized the contents of the cause of fault corresponding to each of said failure phenomenon about each of each component part and they shown to drawing 5 in it, when it has the column of the part number 501, a sequence number 502, the cause epitome 503, and the detail explanation 504 and each component part breaks down, the epitome and detail explanation of the contents which are considered to be the cause are set up according to the phenomenon (according to sequence number).
[0034] Here, the cause epitome 503 is a keyword which explains briefly the failure generated ["line failure"]. The detail explanation 504 is detailed explanation of the cause of the generated failure, for example, the explanatory note of "reflection of a signal having arisen at the termination of a circuit, and it having denied each other signal transmission, and having become communication link impossible, since the terminator of a circuit separated" is registered.
[0035] As the dummy cause-of-fault list table 55 memorized the contents of the cause of fault of the false corresponding to each of said failure phenomenon about each of each component part and they shown to drawing 6 in it It has the column of the part number 601, a sequence number 602, dummy part number (1) 603, dummy part number (2) 604, dummy sequence number (1) 605, and dummy sequence number (2) 606. The failure components of a fake cause of fault and a false corresponding to each of said failure phenomenon are set up about each of each component part.
[0036] Here, while the component part of part number =1 breaks down and the phenomenon of sequence number =1 is presented, dummy part number (1) 603 and dummy part number (2) 604 display the failure phenomenon of fake failure components on coincidence, and they are set up in order to make a right cause of fault when the component part of part number =1 breaks down answer. Therefore, when selecting dummy components, difficulty becomes [the direction] high although true failure components and a true failure phenomenon are similar.
[0037] The virtual-system maintenance table 56 is what memorized the data of the component part of virtual LAN which the user built using virtual LAN construction processing. As shown in drawing 7 , it has the column of a reference number 701, the part number 702, a name 703, a failure rate 704, the rate

705 of degradation, and the phenomenon total 706. A reference number is attached about each components which constitute the virtual LAN which the user built, and the part number, a name, a failure rate, the rate of degradation, and a phenomenon total are set up according to the reference number.
[0038] In this case, the connection relation of each component part is also registered.
[0039] Here, a reference number 701 is a number assigned to a meaning to each of virtual LAN structure-of-a-system components. A reference number 701 is assigned to components each to the part number 702 being assigned according to the class of the component, as for the difference with the part number 702. Therefore, within a virtual LAN system, one component can be specified as a meaning by specifying a reference number 701. Moreover, a reference number 701 has the role of the major key of the virtual-system maintenance table 56.
[0040] In case virtual-LAN construction processing 11 performs the processing which builds the network of imagination to the computer 1 interior by the data of the component part which the user specified among the data of the component part registered into the collection table 51 of components and virtual LAN builds, a user chooses desired components from the component part list in the collection table 51 of components displayed on a display 3 by every one actuation of a mouse 4, and performs the actuation which connects on the display screen. Therefore, the connection relation of each component part becomes clear uniquely with the arrangement location on a screen. This arrangement location is registered into said virtual-system maintenance table 56 as data in which the connection relation of each component part is shown, and the data about the virtual LAN of the reference number which corresponds by specifying a reference number are read from the virtual-system maintenance table 56, and are reproduced on the display screen of a display 3.
[0041] The system-operating-status simulator processing (MTBF calculation means) 12 Elect at random [a virtual LAN component part / any one], and the failure rate of the election component is compared with the virtual failure rate generated with the random number. The 1st processing which repeats the processing which regards it as what the failure generated on election components when the virtual failure rate is smaller, and updates the count counted value of a failure the number of predetermined times, While computing MTBF based on said count counted value of a failure in the time of becoming the count of predetermined The rate of degradation of each component part amends all the failure rates of a virtual LAN component part. After permuting by the failure rate after amending the failure rate of the component part in the virtual-system maintenance table 56, when the processing taken over to said 1st processing is repeated by a user's predetermined number and repeated by a user's predetermined number, processing of **** 2 which outputs MTBF according to each repeating unit is performed.
[0042] The trouble-shooting processing 13 is elected at random [a virtual LAN component part / any one]. The failure rate of the election component is compared with the virtual failure rate generated with the random number. It is regarded as what the failure generated on election components when a virtual failure rate was small. Acquire the contents of the failure phenomenon of the election component, a cause of fault, and the fake cause of fault from the failure phenomenon list cause-of-fault list table [dummy cause-of-fault list] 53, 54, and 55 at random, and it is made to display on the display screen. To the failure phenomenon furthermore displayed, the cause of fault which the user answered judges whether it is a correct answer, and outputs the message of a judgment result.
[0043] Next, based on the flow chart of drawing 8 , drawing 10 , drawing 12 , and drawing 14 , actuation of the LAN simulator of this operation gestalt is explained.
[0044] First, this simulator displays the LAN simulator menu 901 as shown in the display screen of a display 3 at drawing 9 immediately after starting.
[0045] Then, a user starts processing [which he wishes by inputting a processing number into the processing number input area 901 of a menu screen 901 using a keyboard 2] (step 801). As opposed to the processing number as which the computer 1 was inputted into the processing number input area 902 of a menu screen 901 by the keyboard 2 by input number judging processing of step 805 and step 808 When the inputted processing number is '1', "virtual LAN system-construction processing" 11 are started (step 811). When the inputted processing number is '2', "operation situation simulation processing" 12

are started (step 810), and when the inputted processing number is '3', "trouble-shooting simulation processing" 13 are started (step 809).
[0046] In this case, when the inputted processing numbers are not any of "1", "2", and "3", either, by input data check processing of step 802, and judgment processing of the input error of step 803, it progresses to step 807, an error message is displayed on the message indicator field 903 of a menu screen 901, and reinput of a processing number is demanded from a user.
[0047] Moreover, also when a processing number '2' and '3' are chosen before a virtual LAN system construction, by judgment processing of "? built [virtual LAN]" of step 806, it progresses to step 807, an error message is displayed on the message indicator field 903 of a menu screen 901, and construction of a virtual LAN system is demanded from a user. Hereafter, sequential explanation is given about each of the selected processing.
[0048] When a processing number '1' is chosen by the user and "virtual LAN system-construction processing" 11 are started, the virtual LAN construction screen 1101 as shown in drawing 11 is displayed on a display 3.
[0049] The flow chart shows the detail of the virtual LAN construction processing 11 to drawing 10 .
[0050] A user performs components call actuation on the virtual LAN construction screen 1101 of drawing 11 , in order to build LAN of the request which consisted of desired component parts on the display screen of a display 3. For example, it depends keyboard 2 and an PF1 key stroke is performed (step 1011). However, when completion actuation is performed, it returns to drawing 8 by judgment processing of step 1012.
[0051] When an PF1 key stroke is performed, it is judged by judgment processing of a thing and step 1013 in which components call actuation was performed, and progresses to step 1014. Two or more component part data required in order to build desired virtual LAN from the collection table 51 of components are taken out, and the collection display screen 201 of components shown in drawing 2 is expressed as this step 1014.
[0052] Since the components displayed on the collection display screen 201 of components are displayed in an icon format If a user chooses a desired components icon using a mouse 4, the part number assigned to the components icon will be acquired (step 1015). The components property list table 52 is searched by using the part number as a search key (step 1016), and the property data (the part number 301, a name 302, a failure rate 303, the rate 304 of degradation, phenomenon total 305) of the components which the user chose are acquired (step 1017). And it evacuates to the work area of the main memory of a computer 1 by making into a reference number 701 sequence that components were chosen (step 1018).
[0053] A user will perform completion actuation (it is an PF9 key stroke by the keyboard 2) at the time, if only a count equal to the number of the component parts which need the above-mentioned actuation finishes choosing all components required for a virtual LAN system construction repeatedly. Then, the property data evacuated to the work area through error-checking processing of step 1020 and error judging processing of step 1021 are registered into the virtual-system maintenance table 56 by judgment processing of step 1019 (step 1022).
[0054] In this case, in error-checking processing of step 1020, when it confirms whether components surely required for a virtual LAN system construction are missing and there is lack, an error message is displayed on the message indicator field 1103 of the virtual LAN system-construction screen 1101 of drawing 12 (step 1023).
[0055] Moreover, when a required components icon is chosen and the components icon is arranged in the location of a request of the virtual LAN system creation field 1102, the components icon is fixed to the location. And the following components icon is chosen and it arranges in a desired location, and by actuation of connecting by the cable icon, the virtual LAN system which consisted of desired components can be built on the display screen of a display 3, and the property data of the component part can be registered into the virtual-system maintenance table 56.
[0056] In addition, the collection screen 201 of components is displayed on the periphery section of the virtual LAN system creation field 1102.

[0057] Moreover, processing can be returned to the menu screen 901 of drawing 9 by performing the completion time of storing of property data, or cancellation actuation (it being PF key actuation by the keyboard 2).
[0058] Next, a menu screen 901 explains actuation when "operation situation simulation processing" 12 of a processing number '2' are chosen with reference to the flow chart of drawing 12 .
[0059] Starting of the operation situation simulation processing 12 displays the operation situation simulation screen 1301 as shown in a display 3 at drawing 13 first.
[0060] Then, a user inputs operation years into the operation years input area 1302 of this operation situation simulation screen 1301 (step 1201). this alter operation -- for example, the keyboard 2 -- the operation years which work a virtual LAN system are inputted by therefore inputting the integral value of "1" - "9." the operation years inputted at this time -- a convention -- when it is out of range (for example, except 1 - 9), an error message is displayed on the message indicator field 1303 of the operation situation simulation screen 1301, and reinput of operation years is urged to it.
[0061] When the inputted operation years are convention within the limits, the property data (a reference number 701, the part number 702, a name 703, a failure rate 704, the rate 705 of degradation, phenomenon total 706) of a virtual LAN system are read into the memory in a computer 1 from the virtual-system maintenance table 56. Then, a "preparation completion message" is displayed on the message indicator field 1303 of the operation situation simulation screen 1301, and it waits for simulation initiation actuation of a user.
[0062] A user starts operation situation simulation after the display of a "preparation completion message" by initiation actuation (it is an PF9 key stroke by the keyboard 11).
[0063] operation situation simulation -- the following procedures (it is called 1 Monte Carlo step) -- for example, it performs repeatedly by calculating in the formula showing in "the formula 5" and "the formula 6" which mention later the Monte Carlo average <MTBF> and standard deviation <sd> according to the failure number of cases generated in it, and year of MTBF 10000 times (100x100 times).
[0064] In addition, in the following explanation, 1 Monte Carlo step shall be constituted from a repetition cycle of "365x24" time, and this shall be repeated by operation years.
[0065] Here, the definition of the time between failures per 1 Monte Carlo step and the formula of Mean Time Between Failure MTBF are explained.
[0066] Within 1 Monte Carlo step which consists of M times of loop formations, supposing k failures occur, the k-1 time between failures Tb (i) (however, 1 <=i<=k -1) will be observed.
[0067] It is L (psi) (however, if it is referred to as L(psi) = 1 and the value of the loop variable at the time of the j-th failure occurring is set to L (j) (however, 1 <=j<=k -1), the time between failures Tb (i) will be defined by the following formula 3.) about the initial value of the variable in ( ) of the Monte Carlo loop formation.
[0068]
[Equation 3]

$$T_{B(J)} \equiv L_{(J)} - L_{(J-1)} \quad (1 \leqq j \leqq K-1)$$

[0069] At this time, MTBF per 1 Monte Carlo step is defined by the following formula 4.
[0070]
[Equation 4]

$$MTBF = \frac{1}{K-1} \sum_{j=1}^{K-1} T_{B(J)}$$

[0071] Next, if Mean Time Between Failure observed at the each i-th step is set to MTBF (i) (however, 1 <=i<=S) with the Monte Carlo simulation which consists of S Monte Carlo steps, the Monte Carlo average <MTBF> and standard deviation <sd> of Mean Time Between Failure will be computed with the following formula 5 and a formula 6.
[0072]

[Equation 5]

$$\langle MTBF \rangle = \frac{1}{S} \sum_{i=1}^{S} MTBF_{(i)}$$

[0073]

[Equation 6]

$$\langle sd \rangle = \sqrt{\frac{1}{S} \sum_{i=1}^{S} \left(MTBF_{(i)} - \langle MTBF \rangle \right)^2}$$

[0074] In drawing 12 , first, q failure counter variables are prepared and initial value is set to "0" (step 1201). Here, q expresses the total of the components which constitute a virtual LAN system.
[0075] Next, it is "365x24" ********** about processing of steps 1202-1207.
[0076] First, at step 1203, the uniform integer random number R1 of [1, q] is generated. And it considers as the reference number of the components with which failure generates the random number R1 acquired to predetermined timing, and the failure rate 704 (it is hereafter expressed as P for simplification) of the applicable components of the virtual LAN system read into the memory of a computer 1 is acquired by using the reference number as a search key. That is, it elects at random [the components which constitute a virtual LAN system with a random number R1 / one].
[0077] Next, the uniform real number random number R2 of [0, 1] is generated. This random number R2 becomes the comparison criteria of the failure rate of each part article. This random number R2 is acquired to predetermined timing, and if it R2<P Comes to compare with the failure rate P of the components elected at random, it will be regarded as that to which that election component broke down, and will progress to step 1205 through the judgment of step 1204. If it R2>P Becomes, it will not consider as failure generating but will return to step 1202.
[0078] At step 1205, only "1" counts up the value of the R1 position failure counter corresponding to a random number R1.
[0079] Next, at step 1206, as the formula 3 showed, the difference of the operation years loop counter at the time of failure generating and a current operation years loop counter is calculated as the time between failures last time.
[0080] Next, at step 1208, if the value of an operation years loop counter becomes the integral multiple of "365x24", MTBF per 1 Monte Carlo step will be calculated by totaling the failure number of cases for which it asked at step 1205, and calculating based on a formula 4 by year from the time between failures for which it asked at step 1206 further.
[0081] Moreover, the failure rate of each part article is re-calculated based on a current failure rate and the current rate of degradation from the definition of the rate of degradation of a formula 2, and it considers as the failure rate which uses the failure rate of the re-calculation result henceforth. That is, the failure rate 704 of each part article of the virtual LAN system stored in the memory of a computer 1 is permuted by the failure rate of a re-calculation result.
[0082] Next, at step 1210, based on a formula 5, it asks for the Monte Carlo average <MTBF> and standard deviation <sd> by year from MTBF per 1 Monte Carlo step of a "365x24x operation years" individual, and the average by year of the failure number of cases is calculated similarly.
[0083] If the average of the failure number of cases and <MTBF> which were generated, and count of <sd> are completed, <MTBF> of a count result will be displayed on the MTBF viewing area 1304 of the operation situation simulation screen 1301 by year, and standard deviation <sd> will be displayed on the error viewing area 1305 by year, and the average by year of the failure number of cases will be further displayed on the failure generating number-of-cases viewing area 1306.
[0084] When a user does termination actuation (it is PF11 key stroke by the keyboard 2), it returns to a menu screen 901.
[0085] Next, a menu screen 901 explains actuation when "trouble-shooting simulation processing" 13 of a processing number '3' are chosen with reference to the flow chart of drawing 14 .

[0086] Starting of the trouble-shooting simulation processing 13 displays the trouble-shooting simulation screen 1501 as shown in drawing 15 .
[0087] A computer 1 first reads the property data of the virtual LAN structure-of-a-system components after the display of the trouble-shooting simulation screen 1501, and in the virtual system table 56 into the memory of the computer 1 interior.
[0088] Then, the following procedures are performed and it waits for a user's input until a user performs termination actuation (it is PF key actuation by the keyboard 2) and returns processing to a menu screen 901.
[0089] When a user directs trouble-shooting simulation initiation by the key stroke of a keyboard 2, a test problem is first created by processing of steps 1405-1409.
[0090] At step 1405, the uniform integer random number R1 of [1, q] is generated. q is the total of virtual LAN system configuration components. And this random number R1 is acquired to predetermined timing, and it considers as the reference number of the components which failure generates. And the failure rate 704 (it describes hereafter for [P] simplification) of the virtual LAN system configuration components read into the memory of the computer 1 interior and the phenomenon total 706 (it describes hereafter for [M] simplification) are acquired by using the reference number as a search key.
[0091] Next, at step 1406, the uniform real number random number R2 of [0, 1] is generated. And he examines the existence of failure generating by performing the size judging of a random number R2 and a failure rate P acquired to predetermined timing. If it R2<P Becomes, it will be regarded as failure generating and will progress to step 1407. When other, it does not consider as failure generating but returns to step 1405.
[0092] At step 1407, the uniform integer random number R3 of [1, M] is generated. M is the phenomenon total acquired at step 1405. And the failure phenomenon list (drawing 4) which considers as the sequence number of the phenomenon which generated that random number R3, and exists in the memory of the computer 1 interior by using this sequence number R3 and part number R1 as a search key is searched, and the contents 403 of a phenomenon are acquired. Next, the cause-of-fault list (drawing 5) which exists in the memory of the computer 1 interior similarly by using the part number R1 and a sequence number R3 as a search key is searched, and the cause epitome 503 and the detail explanation 504 are acquired.
[0093] Next, the dummy cause-of-fault list (drawing 6) which exists in the memory of the computer 1 interior as well as step 1407 by using the part number R1 and a sequence number R3 as a search key is searched with step 1408, and dummy part number (1) 603, (2) 604, dummy sequence (1) 605, and (2) 606 are acquired.
[0094] Next, the cause epitome 503 is acquired by using the dummy part number (1) 603 acquired, (2) 604, dummy sequence (1) 605, and (2) 606 as a search key.
[0095] Next, the contents 403 of a phenomenon acquired at step 1407 are expressed to the phenomenon viewing area 1503 of the trouble-shooting simulation screen 1501 as step 1409. Next, the cause epitome 503 acquired at step 1407 to the cause viewing area 1504 of the trouble-shooting simulation screen 1501 and the epitome of the cause of a dummy acquired at step 1408 are displayed on the ascending order of a sequence number.
[0096] The test problem based on the virtual LAN system which the user itself built is created by this, and a user is shown. In this phase, the trouble-shooting simulation processing 13 serves as reply waiting from a user.
[0097] Then, if a user inputs the reply to a phenomenon into the reply input area 1505 of the trouble-shooting simulation screen 1501 by reply actuation, for example, the integral-value input of "1" - "3" in a keyboard 2 The trouble-shooting simulation processing 13 This inputted reply examines whether it is a correct answer (steps 1403 and 1412). If it is a correct answer, a correct answer message will be displayed on the message indicator field 1502 of the trouble-shooting simulation screen 1501 (step 1413), and if it is a wrong answer, an error message will be displayed on the message indicator field 1502 (step 1414).

[0098] When a user performs description actuation, for example, the PF9 key stroke in a keyboard 2, here, (step 1410) and the description screen 1601 shown in drawing 16 are displayed (step 1411). Moreover, when a problem setting-actuation, for example, the PF8 key stroke in a keyboard 2, is performed (step 1404), it returns to step 1405.
[0099] Moreover, when termination actuation, for example, PF11 key stroke in a keyboard 2, is performed, processing is returned to a menu screen 901.
[0100] In addition, the cause epitome and detail explanation which were acquired at step 1407 are expressed to the cause viewing area 1602 and the detail explanation viewing area 1603 as the description screen 1601.
[0101] As mentioned above, according to this operation gestalt, the network of imagination is built inside a computer. It elects at random [the virtual network component part / any one]. The failure rate of the election component is compared with the virtual failure rate generated with the random number. When a virtual failure rate is small, while computing MTBF based on the count counted value of a failure in the time of becoming the count repetition of predetermined, and the count of predetermined about the processing which regards it as what the failure generated on election components, and updates the count counted value of a failure Since it was made to output MTBF according to each repeating unit when the processing which amends all the failure rates of a virtual network component part with the rate of degradation of each component part was repeated by a user's predetermined number and repeated by a user's predetermined number, If one year is set as the value "365x24=8760" classified by one time basis as a count of 1 Monte Carlo step, MTBF after progress will be acquired from operation initiation by repeating 1 Monte Carlo step once for one year.
[0102] By this, the dependability of a network system including secular change of a component part can be promptly shown for numeric values, such as MTBF, and management business can be supported.
[0103] Moreover, since the quantitive comparison with the case where it does not consider as the case where a server machine etc. is duplex-ized can be performed easily, it becomes possible to grasp the economical futility by having duplex-ized etc. quantitatively.
[0104] Moreover, it elects at random [the built virtual network component part / any one]. The failure rate of the election component is compared with the virtual failure rate generated with the random number. It is regarded as what the failure generated on election components when a virtual failure rate was small. The test problem about a cause and a phenomenon is set by acquiring the contents of the failure phenomenon of the election component, a cause of fault, and the fake cause of fault from a failure phenomenon list table, a cause-of-fault list table, and a dummy ****** list table at random, and displaying on the display screen. Since it judges whether it is a correct answer by making the receiving reply input so that the setting a problem may not exist, and he is trying to output the message of a judgment result, it becomes possible to train a network administrator efficiently promptly.
[0105] In addition, in the above-mentioned operation gestalt, although the example which computes MTBF by building a virtual LAN system was given and explained, this invention is not limited to this and can be applied to the simulation of various kinds of networks, such as WAN. In this case, it cannot be overemphasized that the contents of various kinds of tables are set as a suitable thing according to the scale and class of network system, and the description.
[0106]
[Effect of the Invention] According to this invention, the dependability of a network system including secular change of a component part can be promptly shown for numeric values, such as MTBF, and management business can be supported so that clearly from the above explanation.
[0107] Moreover, since the quantitive comparison with the case where it does not consider as the case where a server machine etc. is duplex-ized can be performed easily, it becomes possible to grasp the economical futility by having duplex-ized etc. quantitatively.
[0108] Furthermore, it becomes possible to train a network administrator efficiently promptly.

[Translation done.]

* NOTICES *

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TECHNICAL FIELD

[Field of the Invention] This invention relates to the network simulator and the storage for network simulations which perform the exchange or the education of management business of a network administrator, such as LAN.

[Translation done.]

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PRIOR ART

[Description of the Prior Art] In recent years, a communication line is connected with a computer and the network system of various kinds of scales, such as LAN, WAN, etc. which made information, such as a document, and an image, voice, exchangeable between premises or a long distance point, is developed.
[0003] In such a network system, if the part used as nuclei, such as a server machine and a communication line, breaks down, the whole network or a part will become a serious situation, like employment becomes impossible.
[0004] Then, in the former, by duplex-izing a server, a disk, a communication line, etc., redundancy is given to a system and the measures which raise dependability are taken.
[0005] Moreover, it faces introducing the server machine and client machine which are a network component, and it is being considered that system-wide dependability becomes high by selecting what has a failure rate low as much as possible.
[0006] However, this kind of network system is equipped with the flexibility in which network devices, such as a client machine, are fluctuated if needed, as one description. For this reason, even if it integrates the failure rate of each components, such as a server machine, a client machine, and a communication line, and estimates a system-wide failure rate at the time of the beginning of mission of a network system, that estimate will change with the changes in a network device a lot.
[0007] Then, in the former, at every change in a network device, a system-wide failure rate is re-calculated by the help, and to grasp system-wide dependability by the count result is tried.

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EFFECT OF THE INVENTION

[Effect of the Invention] According to this invention, the dependability of a network system including secular change of a component part can be promptly shown for numeric values, such as MTBF, and management business can be supported so that clearly from the above explanation.
[0107] Moreover, since the quantitive comparison with the case where it does not consider as the case where a server machine etc. is duplex-ized can be performed easily, it becomes possible to grasp the economical futility by having duplex-ized etc. quantitatively.
[0108] Furthermore, it becomes possible to train a network administrator efficiently promptly.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, when time amount and an effort are applied by the approach of re-calculating a system-wide failure rate and it requires emergency by the help, there is a problem that it cannot respond promptly.

[0009] Moreover, as a numeric value which shows dependability quantitatively, although there are numeric values, such as MTBF (Mean Time Between Failure) and an operating ratio, also in consideration of secular change, numeric values other than the failure rate of each component part, such as such MTBF, are calculated, and there is a problem that it cannot show promptly.

[0010] Furthermore, though dependability is raised by performing duplex-ization, since the absolute comparison of dependability with the case where it does not duplex-ize cannot be performed, there is a problem that possibility that gave improvement in dependability beyond the dependability demanded, and the futility of cost has arisen, and its condition of not filling demand dependability only with duplex-ization cannot be grasped, conversely.

[0011] on the other hand, the concept of the dependability of a network system is indefinite -- by 7, the network system was actually built, about acquisition of the management technique of the manager who manages this, conventionally, study with books and an actual management experience are cores, and great time amount and cost have started training of a manager. For this reason, educational system implementation which trains a new manager efficiently promptly in preparation for the case where reduction and the manager of cultivation cost take the place etc. is desired.

[0012] Made in order that this invention may solve such a problem, the 1st purpose presents promptly the dependability of a network system including secular change of a component part for numeric values, such as MTBF, and is to offer the network simulator and the storage for network simulations which can support management business.

[0013] The 2nd purpose of this invention enables trouble-shooting training, and is to offer the network simulator and the storage for network simulations which can train a network administrator efficiently.

[Translation done.]

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3.In the drawings, any words are not translated.

MEANS

[Means for Solving the Problem] The component part table which memorized the data of two or more component parts which are needed when building a network in order that this invention may attain the 1st purpose of the above, The components property list table which memorized the property data containing the failure rate of each component part, and the rate of degradation accompanying secular change, A virtual network construction means to connect the data of the component part which the user specified among the data of the component part of said component part table by the connection relation specified by a user, and to build the network of imagination inside a computer, A maintenance means to acquire the property data of the component part which constitutes the built virtual network from said components property list table, and to hold as a virtual network component part property data list, Elect at random [a virtual network component part / any one], and the failure rate of the election component is compared with the virtual failure rate generated with the random number. The 1st processing which repeats the processing which regards it as what the failure generated on election components when a virtual failure rate is small, and updates the count counted value of a failure the number of predetermined times, While computing MTBF based on said count counted value of a failure in the time of becoming the count of predetermined The rate of degradation of each component part amends all the failure rates of a virtual network component part. After permuting by the failure rate after amending the failure rate of the component part in said maintenance means, When the processing taken over to said 1st processing is repeated by a user's predetermined number and repeated by a user's predetermined number, it is characterized by establishing an MTBF calculation means to perform 2nd processing which outputs MTBF according to each repeating unit.
[0015] If one year is set as the value "365x24=8760" classified by one time basis as a count of predetermined in the 1st processing here, MTBF after progress will be acquired by repeating the 1st processing once for one year.
[0016] Moreover, the component part table which memorized the data of two or more component parts which are needed when building a network in order to attain the 2nd purpose of the above, The components property list table which memorized the property data containing the failure rate of each component part, and the rate of degradation accompanying secular change, The failure phenomenon list table which memorized the contents of the failure phenomenon according to the phenomenon about each of each component part, The cause-of-fault list table which memorized the contents of the cause of fault corresponding to each of said failure phenomenon about each of each component part, The fake cause-of-fault list table which memorized the contents of the cause of fault of the false corresponding to each of said failure phenomenon about each of each component part, A virtual network construction means to connect the data of the component part which the user specified among the data of the component part of said component part table by the connection relation specified by a user, and to build the network of imagination inside a computer, A maintenance means to acquire the property data of the component part which constitutes the built virtual network from said components property list table, and to hold as a virtual network component part property data list, Elect at random [a virtual network component part / any one], and the failure rate of the election component is compared with the virtual failure rate

generated with the random number. It is regarded as what the failure generated on election components when a virtual failure rate was small. The contents election means of setting a problem which acquires the contents of the failure phenomenon of the election component, a cause of fault, and the fake cause of fault from said failure phenomenon list table, a cause-of-fault list table, and a fake cause-of-fault list table at random, and is displayed on the display screen, To the displayed failure phenomenon, the cause of fault which the user answered judges whether it is a correct answer, and is characterized by having a judgment means to output the message of a judgment result.
[0017]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is concretely explained using a drawing.
[0018] Drawing 1 is the system configuration Fig. showing the operation gestalt of the LAN simulator which applied this invention, and consists of a computer 1 and external storage 5, such as the keyboard 2 which is the input/output equipment, a display 3, a mouse (pointing device) 4, and a hardware disk.
[0019] In order to show promptly the dependability of a network system including secular change of network configuration components for numeric values, such as MTBF, to enable to support management business and trouble-shooting training and to train a network administrator efficiently, the virtual LAN construction processing 11, the system-operating-status simulator processing 12, and the trouble-shooting processing 13 are included in the interior of a computer 1 as an application program.
[0020] These the processings 11, 12, and 13 of each are memorized by storages, such as CD-ROM, in the data format which can perform a computer 1, and the user of a computer 1 is provided with them.
[0021] On the other hand, the collection table (component part table) 51 of components, the components property list table 52, the failure phenomenon list table 53, the cause-of-fault list table 54, the dummy cause-of-fault list table (fake cause-of-fault list table) 55, and the virtual-system maintenance table 56 are formed in external storage 5.
[0022] The collection table 51 of components memorized the data of two or more component parts which are needed when a user builds a desired virtual network, and as shown in drawing 2 , it has memorized the data for displaying component parts, such as Ethernet, a token ring, and a client machine, in an icon format. [0023] As the components property list table 52 memorized the property data containing the failure rate of each component part, and the rate of degradation accompanying secular change and they shown to drawing 3 in it, it has the column of the part number 301 attached to component parts, such as Ethernet, the name 302 of a component part, a failure rate 303, the rate 304 of degradation, and the phenomenon total 305, and the name of component parts, such as Ethernet, the rate of failure rate degradation, and the phenomenon total are set as each column according to the part number.
[0024] Here, a failure rate is the failure probability of occurrence per hour of the components specified with the part number 301, and it defines by the count of failure per hour. That is, supposing T hours carries out N time failure, as Components n show the failure rate Pn of this component n in a formula (1), it defines.
[0025]
[Equation 1]

$$P_n \equiv \frac{N}{T}$$

[0026] The rate of degradation is an index showing the long term deterioration of the components specified with the part number 301, and it is the increment of the failure probability of occurrence for every progress, and will express by the percentage for one year. That is, if the failure rate after the operation during Pn (phi) and one year is set to Pn (1) for the failure rate at the time of the factory shipments of Components n, rate of degradation alphan will be defined by the formula (2).
[0027]
[Equation 2]

$$\alpha_n \equiv \left(\frac{P_{n(1)}}{P_{n(\phi)}} - 1 \right) \times 100$$

[0028] For example, the failure rate of a certain components is "0.5", and when the rate of degradation of this component is "20", it will be set to "0.5x (100+20) / 100= 0.6" if the failure rate of the next year of this component is calculated.
[0029] Moreover, a phenomenon total is a total of a phenomenon which appears when the component part of ****** specified with the part number 301 is breaking down, and it is set up based on an experience value. For example, "1" means that there is a phenomenon at the time of failure only in one kind in the phenomenon total.
[0030] The contents of the phenomenon of appearing when it has the column of the part number 401, a sequence number 402, and the contents 403 of a phenomenon and each component part breaks down, as the failure phenomenon list table 53 memorized the contents of the failure phenomenon according to a phenomenon about each of each component part and they shown to drawing 4 in it are memorized according to the sequence number.
[0031] A sequence number 402 is an identification number attached in order to distinguish two or more phenomena belonging to the same part number uniquely, and serves as a major key by two items, the part number 401 and a sequence number 402. A number is assigned sequentially from "1" within each part lot number number. The contents 403 of a phenomenon are the contents of the phenomenon generated to the LAN system, for example, "the whole network was downed" etc.
[0032] Here, the number of the contents of a phenomenon is equal to the value of the phenomenon total 305 of the components property list table 52. That is, all the contents of the phenomenon of appearing when each component part breaks down give a sequence number to this failure phenomenon list table 53, and are set to it.
[0033] As the cause-of-fault list table 54 memorized the contents of the cause of fault corresponding to each of said failure phenomenon about each of each component part and they shown to drawing 5 in it, when it has the column of the part number 501, a sequence number 502, the cause epitome 503, and the detail explanation 504 and each component part breaks down, the epitome and detail explanation of the contents which are considered to be the cause are set up according to the phenomenon (according to sequence number).
[0034] Here, the cause epitome 503 is a keyword which explains briefly the failure generated ["line failure"]. The detail explanation 504 is detailed explanation of the cause of the generated failure, for example, the explanatory note of "reflection of a signal having arisen at the termination of a circuit, and it having denied each other signal transmission, and having become communication link impossible, since the terminator of a circuit separated" is registered.
[0035] As the dummy cause-of-fault list table 55 memorized the contents of the cause of fault of the false corresponding to each of said failure phenomenon about each of each component part and they shown to drawing 6 in it It has the column of the part number 601, a sequence number 602, dummy part number (1) 603, dummy part number (2) 604, dummy sequence number (1) 605, and dummy sequence number (2) 606. The failure components of a fake cause of fault and a false corresponding to each of said failure phenomenon are set up about each of each component part.
[0036] Here, while the component part of part number =1 breaks down and the phenomenon of sequence number =1 is presented, dummy part number (1) 603 and dummy part number (2) 604 display the failure phenomenon of fake failure components on coincidence, and they are set up in order to make a right cause of fault when the component part of part number =1 breaks down answer. Therefore, when selecting dummy components, difficulty becomes [the direction] high although true failure components and a true failure phenomenon are similar.
[0037] The virtual-system maintenance table 56 is what memorized the data of the component part of virtual LAN which the user built using virtual LAN construction processing. As shown in drawing 7 , it has the column of a reference number 701, the part number 702, a name 703, a failure rate 704, the rate

705 of degradation, and the phenomenon total 706. A reference number is attached about each components which constitute the virtual LAN which the user built, and the part number, a name, a failure rate, the rate of degradation, and a phenomenon total are set up according to the reference number.
[0038] In this case, the connection relation of each component part is also registered.
[0039] Here, a reference number 701 is a number assigned to a meaning to each of virtual LAN structure-of-a-system components. A reference number 701 is assigned to components each to the part number 702 being assigned according to the class of the component, as for the difference with the part number 702. Therefore, within a virtual LAN system, one component can be specified as a meaning by specifying a reference number 701. Moreover, a reference number 701 has the role of the major key of the virtual-system maintenance table 56.
[0040] In case virtual-LAN construction processing 11 performs the processing which builds the network of imagination to the computer 1 interior by the data of the component part which the user specified among the data of the component part registered into the collection table 51 of components and virtual LAN builds, a user chooses desired components from the component part list in the collection table 51 of components displayed on a display 3 by every one actuation of a mouse 4, and performs the actuation which connects on the display screen. Therefore, the connection relation of each component part becomes clear uniquely with the arrangement location on a screen. This arrangement location is registered into said virtual-system maintenance table 56 as data in which the connection relation of each component part is shown, and the data about the virtual LAN of the reference number which corresponds by specifying a reference number are read from the virtual-system maintenance table 56, and are reproduced on the display screen of a display 3.
[0041] System-operating-status simulator processing

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the system configuration Fig. showing the operation gestalt of the LAN simulator which applied this invention.
[Drawing 2] It is drawing showing the example of a screen display of the collection of components.
[Drawing 3] It is the block diagram of a components property list table.
[Drawing 4] It is the block diagram of a failure phenomenon list table.
[Drawing 5] It is the block diagram of a cause-of-fault list table.
[Drawing 6] It is the block diagram of a dummy cause-of-fault list table.
[Drawing 7] It is the block diagram of a virtual-system maintenance table.
[Drawing 8] It is the flow chart which shows the processing process which chooses two or more functions.
[Drawing 9] It is drawing showing the example of a display of a LAN simulator menu screen.
[Drawing 10] It is the flow chart which shows virtual LAN system-construction processing.
[Drawing 11] It is drawing showing the example of a display of a virtual LAN system-construction screen.
[Drawing 12] It is the flow chart which shows operation situation simulation processing.
[Drawing 13] It is drawing showing the example of a display of an operation situation simulation screen.

[Drawing 14] It is the flow chart which shows trouble-shooting simulation processing.
[Drawing 15] It is drawing showing the example of a display of a trouble-shooting simulation screen.
[Drawing 16] It is drawing showing the example of a display of a description screen.
[Description of Notations]
1 [-- External storage, 11 / -- Virtual LAN construction equipment, 12 / -- System-operating-status simulation processing, 13 / -- Trouble-shooting simulation processing, 52 / -- A components property list table, 53 / -- Failure phenomenon list table.] -- A computer, 2 -- A keyboard, 3 -- A display, 5

[Translation done.]